UNIVERSITY OF TRENTO - Italy

Doctoral School of Social Sciences

Doctoral programme in Development Economics and Local Systems

Curriculum in Local Systems

Essays on the role of relatedness and entrepreneurship within Smart Specialisation Strategy. Evidence from Italy with a focus on Tuscany.

a dissertation submitted in partial fulfillment of the requirements for the Doctoral degree (Ph.D.) doctoral programme in Development Economics and Local Systems

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Academic Year 2018/2019

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ACKNOWLEDGEMENTS

Undertaking this Ph.D. has represented for me an exceptional life-changing experience. The completion of the present dissertation would not have been possible without the guidance and support that I received from many people.

First of all, I would like to express my profound gratitude to my supervisor professor Luciana Lazzeretti for her motivation and knowledge. Her guidance helped me to deepen concepts and ideas, without settling for standard meaning, but pushing me to see economic phenomena as systemic and multidisciplinary in their essence. Moreover, she has shown me the importance of hard work and curiosity, both fundamental engines in all the phases of the research and generally in our life.

Besides my advisor, I would like to thank Niccolò Innocenti for his wide support in the empirical part of the analysis, but also for his precious general suggestions and encouragement. Particularly, the first paper of the thesis has benefited of many chats and discussions between us that has allowed me to improve the initial draft. In addition, I would like to express my gratitude to Francesco Capone, Stefania Oliva and Amir Maghssudipour to have continuously encouraged me during this journey and to have helped me with various suggestions and comments.

I would like to express my sincere gratitude to Tuscany Region to have hosted me for four months at the offices of Managing Authority of Operational Programme EFRD 2014-2020, directed by Angelita Luciani. In particular, I am sincerely grateful to my tutor Emanuele Fabbri, who introduced me in the world of regional policies, showing me the linkages between the academic theories and the practical aspects of regional governance. Moreover, I thank him for his insightful comments on the second paper of the thesis.

I would thank Professor Mauro Lombardi to have included me in the team of the project "Cantieri40" promoted by Tuscany Region, which gave me the opportunity, during the Ph.D. period, to visit many firms and to understand the points of views and attitudes of different typologies of entrepreneurs towards innovation policies and the Industry 4.0 paradigm.

I am sincerely grateful to Professor Margherita Russo and Professor Elvira Uyarra for their valuable comments on the thesis, which have allowed me to significantly improve the quality of the work.

I would also thank professors and researchers that I met during my path, especially those who contributed to my education enrichment in the first year and those involved in conferences, in which I participated, helped me with comments and suggestions. In particular, many thanks to the professors of the International Ph.D. course on Economic Geography held in Utrecht in 2018, who have provided fundamental suggestions to improve the thesis. Many thanks also to the participants of SMARTER 2018 - Conference on Smart Specialisation and Territorial Development, who gave me important insights to improve the second paper of this thesis.

Many thanks are due to all my colleagues of the Ph.D. programme with whom I shared this important experience, especially my friend Angelo Laudiero.

Finally, I would like to thank my mother and my father for their support and continuous encouragement, even in the hard moments. A special thanks to Isabella that with her love has shown me the importance of passion and determination to achieve a goal. Finally, I thank all my friends for their positive spirit. Without their fundamental support, it would not be possible to write this thesis.

ABSTRACT

Smart Specialisation Strategy (S3) has recently attracted the attention of many scholars, pundits and policy makers involved in regional studies, as a new industrial policy able to fill the gap between the weak capacity of Europe to innovate in comparison to its strong academic base and research institutions. S3 is described as a policy aimed to encourage structural changes, through the generation of new domains of opportunities, according to the strengths and potentialities of each region and therefore with a "place-based" outlook. Its primary element of novelty, in comparison to the previous policy approaches, is constituted by the Entrepreneurial Discovery Process (EDP), which represents the modality among institutions, firms, R&D centres, universities, through which the direction(s) of the structural change is organised.

To study S3, this Ph.D. thesis focuses on two pillars considered central to understand its rationales: relatedness and entrepreneurship. On one hand, the idea of relatedness is useful to understand the economic structure of a territory and its evolution through its network of connections, outlining possible areas of future development. On the other hand, entrepreneurship, somehow a missing dimension of S3, can be considered as part of the process of opportunity scanning to "challenge" inefficiencies of the society through new models of production and consumption, proactiveness of institutions, business development strategies of firms or cultural mindset of people.

The aim of the thesis is to explore this relatedness-entrepreneurship relationship within S3, using a multi-level framework of analysis able to integrate the different aspects of the two concepts, providing theoretical and empirical advancements. The thesis is structured as follows: a general introduction on S3, three papers, which analyse Italy, focusing on the case of Tuscany and some final conclusions that sum up the findings of the papers and provide some further policy insights. The content of the three papers is reported hereinafter.

In the first paper the analysis is conducted in the Italian provinces defining entrepreneurship as the creation of a new business and relatedness as one of the principal mechanisms that could explain the origin of innovation in connection with a given territorial knowledge base. The distinctiveness of this first paper seeds in the study of this relationship across individual industries, computing separate measures of *external* and *internal* relatedness across 27 sectors (among manufacturing and KIBS). The results suggest a broader and positive impact of external relatedness on the concentration of new firms at the territorial level in comparison to the impact of internal relatedness. The implications suggest that Knowledge Spillover Theory of Entrepreneurship can be included in the cognitive framework of S3

(newborns as expression of knowledge exchanged at the local level) and that innovation policies aimed to promote path creation should consider existent strengths of the territories.

The second paper studies the EDP, integrating the concept of relatedness, useful in the initial phases of design and scoping, with the one of institutional entrepreneurship as an expression of the impact of agency in the micro-dynamics that rule the final outcome of innovation policies. This framework is applied to the case of Tuscany, using a mixed methodology. As a first picture of proximity connections between sectors of Tuscany, an original computation of the "Industry Space" of Tuscany is realised (using the methodology of Hidalgo et al., 2007). Then the Technological Districts' managers and/or coordinators are interviewed, as a sort of fact checking with the Industry Space results, to understand how they define their planning strategies and through which mechanisms they integrate knowledge and combine firms and R&D specialities. Results confirm the necessity to integrate the two concepts to obtain a more realistic "policy orientation map", and the broader horizon released by relatedness if deeply analysed with case studies at a micro-level and if directly discussed with some central agents embedded in the regional network of proximities.

The third paper studies the entrepreneurial styles (as real business men) and their ways of integrating and combining knowledge, adopting a micro interpretation on the concept of relatedness. The paper aims to identify what role can play these entrepreneurial figures as fundamental "micro pieces" in the scanning process of future opportunities of regional transformation promoted by S3. The methodology adopts a qualitative approach, using semi-structured interviews administered to a selected set of 24 entrepreneurs in Tuscany. The sample of the entrepreneurs, selected with a purposeful criterion, has been built thanks to the help of key informants. The gathered data are codified with the help of Gioia methodology, in order to derive some characteristics of the entrepreneur and the firms to describe some "emerging properties". Then, a ladder of entrepreneurial typologies, able to group the specific characteristics derived from the interviews, is proposed. Results suggest a "distributed technology transfer model" as a complementary bottom up strategy to converge towards a new cyber-manufacturing regime of production.

Keywords

Smart Specialisation Strategy, Entrepreneurial Discovery Process, entrepreneurship, relatedness, Innovation policy.

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"Complexity economics is neither an add-on to standard economics (see Fontana, 2010), nor does it consist of adding agent-based behavior to standard models. It is a different way of thinking about the economy. It sees the economy not as a system in equilibrium but as one in motion, perpetually "computing" itself—perpetually constructing itself anew. Where equilibrium economics emphasizes order, determinacy, deduction, and stasis, this new framework emphasizes contingency, indeterminacy, sense-making, and openness to change. There is another way to say this. Until now, economics has been a noun-based rather than verb-based science. It has pictured changes over time in the economy function as changes in levels of fixed noun-entities—employment, production, consumption, prices. Now it is shifting toward seeing these changes as a series of verb-actions—forecast, respond, innovate, replace—that cause further actions" (Arthur, 2013, p.19)

"If a system can be reduced to a set of fixed mechanical interactions, providing a predictable, stable and non-innovative future, then it is not complex, not evolutionary and not uncertain". (Allen, 2014, p.266)

LIST OF ABBREVIATIONS

European Commission (EC)

European Regional Development Funds (ERDF)

European Union (EU)

Entrepreneurial Discovery Process (EDP)

Global Value Chain (GVC)

Knowledge Spillover Thoeory of Entrepreneurship (KSTE)

Smart Specialisation Strategy (S3)

Technological District (TD)

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1. Introduction

1.1 Context

Since the first decade of the 2000s, the intensification of environmental problems, the energy security issues, the financial crisis of 2008 and the emergent role of China with its fast and huge economic development have started to seriously menace not only the actual role of Europe, but mainly its future in the geopolitical puzzle (Aghion et al., 2011).

In this rather challenging context, the innovative capacity of Europe, crucial in driving a recovery strategy, has been far below the other global big players, such as US, Japan and recently also China. Some stylised facts depict the "scene":

- the number of unicorns (firms with a "post-money valuation" greater than US$ 1 billion) in 2017 in Europe were 26 in comparison to the 109 of US and 59 of China (EC, 2018);
- the investment of European firms in R&D in the last 15 years has barely grown comparing to the global scenario (EC, 2018);
- in 2018 the first three countries for patent's applicants were extra European (Japan, US and China) and the first 5 firms for the number of patent application were extra European (Huawei, Mitsubishi, Intel, Qualcomm, ZTE Corporation) with a remarkable rise in the last 10 years of Chinese players (WIPO, 2018);
- there has been a critical delay in the development of key digital infrastructures, embedded in the concept of platform economy, with a huge progress made by Israel and Korea (as shown in the GEM report 2018/2019 by Bosma and Kelley, 2018).

These stylised facts show a trend that more than a decade ago was acknowledged by European Institutions, which stimulated an urgent call for a "new industrial policy", able to tackle this scenario, filling the gap between the weaker capacity to innovate and the strong academic base and research institutions (Foray and Van Ark, 2007). Accordingly, within Europe 2020, the European strategy that represents the "shared vision" for the growth of Europe, an initiative to enhance the innovative capacity of European regions was enforced, namely Smart Specialisation Strategy (henceforth S3).

S3 is described as a policy aimed to encourage structural changes, through the generation of new domains of opportunities, according to the strengths and potentialities of each European region and therefore with a "place-based" outlook (Barca, 2009; Foray, 2015). Its primary element of novelty, in comparison to the previous policy approaches, is constituted by the Entrepreneurial Discovery Process (henceforth EDP), which represents the shared modality

among institutions, firms, R&D centres, universities, through which the direction(s) of the structural change is organised (Foray, 2016).

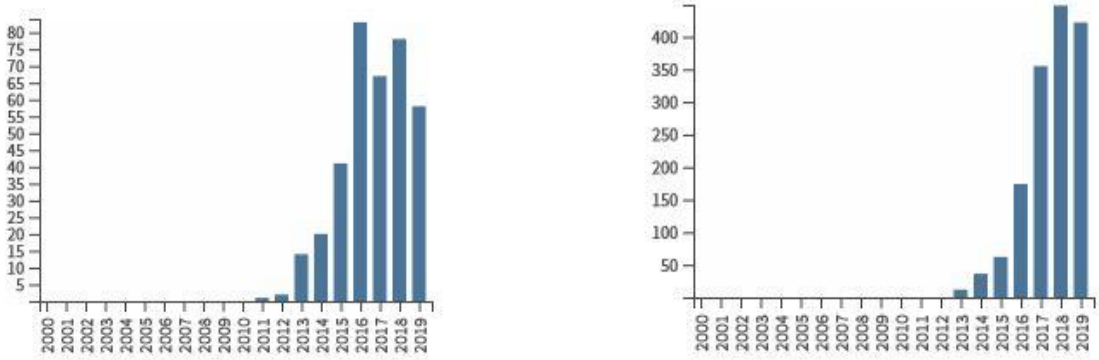
Recently, S3 has attracted the attention of many scholars, as shown by the number of scientific papers and citations that have significantly increased (see Figure 1), positing itself as one of the most debated topics in innovation policy and regional development of the last few years.

Notwithstanding the great interest raised by S3, its rapid adoption and implementation has opened theoretical and empirical points that deserve further elaboration and discussion.

This Ph.D. thesis is framed in this "wake", which calls for theoretical explanations able to identify the essence of S3, as well for empirical contributions able to capture its general features and to show concrete examples of the S3 "at work".

Figure 1. Number of scientific contributions (a) and citations (b) from ISI WOS database for the query "Smart Specialisation"

(a) **(b)**



Source: Author's research on ISI WOS database.

1.2 Problem statement

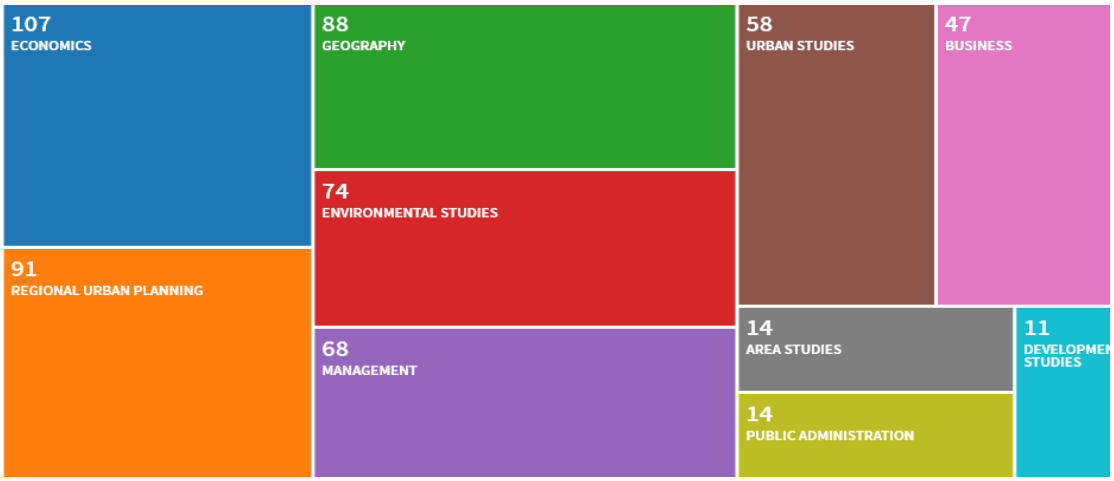
Given the abovementioned novelty of the concept, the starting point of the thesis begun from the definition of S3, with the aim to understand its key principles and vision, emerged by the common elements pointed out by leading scholars in the field of innovation policy.

The S3 supports the idea that it is necessary to adopt a systemic perspective on innovation to cope with local/global socio-economic challenges, allowing each region to build its own strategy, according to its characteristics and potentialities that can delineate specific trajectories of development and create competitive advantages (Foray and Goenaga, 2013). There is the need to set priorities of investment in the areas based on (and/or connected to) regional excellences in terms of technologies/industries, in which agglomeration of resources could represent a vehicle to create new competences and a bridge to promote the transformation of productive structures (OECD, 2013; Foray, 2015; Foray, 2016).

These priorities are "discovered" adopting a "conscious experimentation strategy", based on a bottom-up engagement of the regional actors, namely firms, research leaders, universities, coordinated by the policymakers (Borrás and Jordana, 2016). The policymakers empower with different tools the actors considered most capable to exploit the potentialities found in this interactive process of discovery (the EDP), characterising S3 as a learning approach to innovation (Asheim, 2019). From this representation, it appears how the tenets of S3 derive from different streams of economic literature: innovation studies (e.g. regional innovation systems), local development (e.g. place-based approach), business studies (e.g. entrepreneurship, competitiveness), economic geography (e.g. related variety, regional branching), evolutionary economics (e.g. path dependence).

This multidisciplinary aspect of S3 is confirmed by a web search on the ISI WOS database, which has revealed a broad interest in this topic from many disciplines belonging to the Social Sciences (e.g. in the field of economics, management, geography) as confirmed by recent bibliometric analysis on S3 (Gómez-Núñez, 2014; Fellnhofer, 2018; Lopes et al., 2019).

Figure 2. The most involved 10 research areas for the term "Smart Specialisation"



Source: Author's elaboration on ISI WOS.

Of course, many theoretical approaches can be embraced to explain S3 dynamics and scholars have used different points of view on it, such as regional innovation policy (Asheim, 2019; Morgan, 2017), regional diversification (Iacobucci and Guzzini, 2016; Balland et al., 2018; D'Adda et al., 2019) regional inequality (Ranga, 2018; Trippl et al., 2019; Sörvik et al., 2019) role of institutions (Rodríguez-Pose and Wilkie, 2015; Benner, 2019), green trajectories (Capasso et al., 2019; Steen et al., 2019), socio-economic features (Lopes et al., 2018; Pagliacci et al., 2019), resilience (Bellini et al., 2017; Muštra et al., 2017).

The multiplicity of these research approaches makes clear that a unique discipline able to correctly frame innovation policy and regional development does not exist (Capello and Kroll, 2016). Therefore, studying S3 means observing societal led-challenge mission beyond technology, looking at innovation as a non-linear complex and interconnected system (Foray, and colleagues, 2009; Mazzucato, 2018; Wanzenböck et al., 2019).

However, the choice made for this Ph.D. thesis is to analyse S3, looking inside some elements that can be considered central to grasp its essence. Considering the principles of S3, briefly abovementioned, one of its leading research objectives is to understand how economic inputs connected in networks evolve, and how agents aggregated in firms, located in cities and regions, shape the innovative process at a territorial level (Morgan, 2013; Balland, 2016; Hidalgo, 2018). The emphasis that S3 advocates posed on the idea of discovering what are the priorities, it is basically a matter of knowledge and its combination and how the action of institutions and entrepreneurs contribute to define innovation paths, in the continuous tension between "exploration" and "exploitation" (Foray, 2016; Asheim, 2019).

Hence to study S3, this Ph.D. thesis focuses on two pillars considered central to understand its rationales: relatedness and entrepreneurship. Both concepts are largely used in the branch of regional innovation policy and are fundamental to capture the new logics of the productive dynamics in the current techno-economic scenario. While the concept of relatedness has been widely acknowledged by S3 proponents as a crucial element to describe transformation of economic system (Foray, 2015), some scholars have stressed how entrepreneurship is somehow a "missing dimension", but potentially crucial to study the triggering mechanisms behind S3 (Boschma et al., 2013).

1.3 Purpose statement and structure of the thesis

The choice of relatedness and entrepreneurship as theoretical axes has been made using a combined perspective, derived by the simultaneous adoption of the two concepts in the same theoretical framework, which represents a distinctive point of this work. This is due to the recent interest of economic scholar and policymakers in the relationship between the two, as one of the determinants of economic development in terms of employment and export growth and therefore a key link able to explain regional branching (Boschma and Gianelle, 2014; Content and Frenken, 2016; Content et al., 2019).

Relatedness and entrepreneurship are multifaceted concepts that can be studied referring to different theories, approaches and units of analysis. On one hand, the idea of relatedness originated in the management theory to explain how new products and process development within firms relate to their closer historical successes from a technological point of view (Teece, 1996). Then this concept was adapted also to a macro level to understand the diversification path of cities, regions and countries in terms of technology adoption, innovation trajectories, employment dynamics and exports (Frenken et al., 2007; Hidalgo et al., 2007; Boschma and Iammarino, 2009; Neffke et al., 2011; Rigby, 2015).

On the other hand, also entrepreneurship has a multidimensional character, even broader than relatedness. It can be conceived as the creation of a new business, as labour mobility, proactiveness within an established business, business development strategies to access new markets, networking between firms, or simply as a cultural mindset of people, evidencing the fuzziness and the difficulty to establish a clear border between its different aspects (Boschma and Frenken, 2009; Boschma and Gianelle, 2014; McCann and Ortega-Argilés, 2016).

So, in what terms relatedness and entrepreneurship can be integrated into a single theoretical framework able to explain S3? Entrepreneurship, in this case, can be considered as a process of opportunity scanning to "challenge" the inefficiencies of the society through new discoveries, which in turn can be purposefully organised into new models of production and consumption (Bygrave and Hofer, 1992; Shane and Venkataraman, 2000). Relatedness can be intended as the network of connections between the existent resources of a territory and a novelty element brought by this discovery process, namely the description of a path creation trajectory at a local level (Balland, 2016; Boschma, 2017; Boschma, 2018).

Hence initially to "explore" this relatedness-entrepreneurship relationship, the latter was defined as the creation of a new business (as "innovation carriers"), and relatedness as one of

the principal mechanisms that could explain the origin of innovation in connection with a given territorial knowledge base. This particular perspective considers the theory of *Knowledge Spillover of Entrepreneurship* (KSTE) (Audretsch, 2005) as the missing link between the local knowledge proximity and the ability of new firms to exploit the opportunities left "free" by the incumbents, through a process of knowledge combination and recombination (Audretsch, 2009). In general terms, addressing the link between the local knowledge base expressed by a territory and the capacity to promote new entrepreneurship can theoretically support the logical scheme of S3. This is due to the coherence between the concept of regional branching and the idea to set up new businesses related/unrelated to what the regions can do better.

Nonetheless, these mechanisms do not occur in the same manner in all the regions and across sectors. This is because the absorptive capacity of the systems is different and depends on the action (sometimes combined) of institutions and on the vision of entrepreneurial actors at various levels, which can hardly be measured with univocal metrics. Therefore, the interplay between relatedness and entrepreneurship can not only be inquired at the "macro-level", but also in its more "nuanced features" under different lenses. For instance, analysing the role of agency at the institutional level in the process of knowledge recombination, the nature of knowledge (of what kind, through which relationships, the local-global dialectic), the typologies of local actors involved in the S3 and their capacity to integrate different sources of knowledge of innovation are very relevant dimensions to deepen.

Thus, to disentangle these dynamics, the overarching research question of the thesis is the following:

What are the contributions given by a multilevel framework of analysis composed by relatedness and entrepreneurship to the theoretical and practical aspects of Smart Specialisation Strategy and Entrepreneurial Discovery Process?

In order to answer this macro RQ, it is fundamental to adopt a multilevel framework of analysis, able to examine the relationship of entrepreneurship and relatedness at a macro, meso and micro level, providing possible policy insights for S3. It has been selected a very fruitful "laboratory of analysis" to investigate the S3 phenomenon, namely Italy, principally for two general reasons: Italy is the first producer of papers related to the notion of Smart Specialisation (ISI WOS, 2019 see annex) and is the second recipient at the European level of the European Regional Development Funds with ca 33,5 € billion (Cohesion data, 2019), but one of the worst

European country in terms of ability to spend the allocated budget (Cohesion data, 2019). These facts make particularly challenging the case of Italy.

After a general analysis on the effect of territorial relatedness on the formation of new firms across sectors (object of the first paper), this thesis deepens some of the peculiarities mentioned before, focusing on the case of Tuscany, an Italian region located in the centre of Italy and emblematic expression of the industrial districts. The reason for the choice is due to the profound challenges faced by regions strongly based on industrial districts related to globalisation and economic recession: S3 deals with this structural transformation and Tuscany represents a thought-provoking case. The governance configuration of Regional Government has to consider the new ways of knowledge creation and the new role of entrepreneurs (also in relationship with global dynamics) as pillars to conceive new policy framework and tools of intervention. Moreover, for what concerns the S3 governance structure, the discovery process of Tuscany has been designed to include a broad set of actors which have contributed to define Tuscany strategy with transversal priorities, conceived to enhance the whole productive system of the region, beyond single specialisations.

The possibility offered to the author to make a visiting period of four months at the Managing Authority of Operational Programme EFRD 2014-2020 of Regional Government of Tuscany has allowed to deepen the abovementioned themes. The work conducted on R&D projects, supporting the Regional Government in the monitoring phase of S3, together with the direct contact with the regional policy officers of Tuscany, involved with the building and implementation phases of S3 and EDP, has represented a privileged point of observation, which has stimulated the structuration process of this thesis.

Hereinafter, it is presented the structure of the thesis, which consists of three papers. They represent the three logical steps of the work (see table 1). The second and last chapter of the work corresponds respectively to the theoretical background of the thesis and the final conclusions. This final part aims to answer to the macro RQ posed in this section, illustrating also possible future trajectories of the S3 concept (figure 3 summarises the entire flow).

***First paper**: new firm formation, relatedness and "industry specificity" in the Italian provinces*[1].

What are the effects of relatedness on the creation of a new business? The literature shows contrasting results. Some studies demonstrate that proximity levels between different but related sectors influence positively the birth of new firms. Others point out how the presence of un-related sectors can have a bigger impact on that.

The previous literature has used various approaches to measure relatedness: within plants, between skills of workers, between technology included in the same patent and considering employees in the industrial sectors. The distinctiveness of this works seeds in the study of this relationship across individual industries (27 among manufacturing and KIBS), computing separate measures of *external* and *internal* relatedness for each sector. In particular, this study aims to answer to the following RQ:

- *Do different types of sectoral relatedness influence new firms' creation across industrial sectors?*

The study has been conducted on the Italian provinces, using MOVIMPRESE database for the years 2012-2014 to compute the main variables of the econometric analysis. The results suggest a broader and positive impact of external relatedness on the concentration of new firms at the territorial level in comparison to the impact of internal relatedness, which is more limited and only in one case positive. Moreover, further tests on the effect of the general level of relatedness does not register positive impact on new firms' formation, pointing out the importance to deepen these measures using a lens of industrial specificity.

The first paper concludes that the KSTE (the idea that newborns represent an expression of knowledge exchanged at the local level) can be included in the cognitive framework of the EDP, since investigating the mechanisms of knowledge proximity and recombination that favor the creation of new business, contributes to the understanding of S3, facilitating the vision of policies.

[1] Presented at EURAM, Lisbon, 28 June 2019 and in its preliminary version at the International Ph.D. course on Economic Geography, Utrecht, 10 September 2018.

In the light of S3, the sectoral study of relatedness's impact on new business creation could avoid innovation policy targeted exclusively on high-tech sectors, increasing the awareness of the policymakers regarding the capacity of individual sectors to promote favourable path creation trajectories at the micro-level. Finally, although the KSTE theory is important to explain the mechanisms that link business creation with relatedness, the paper opens new possibilities for discussing these concepts and their relationship more in-depth, through the use of case studies. The two following papers attempt to analyse more deeply the concepts of relatedness and entrepreneurship, starting from the limits highlighted above.

Second paper. *The Entrepreneurial Discovery Process between relatedness and entrepreneurial agency*[2]

The Entrepreneurial Discovery Process (EDP) has been identified by Smart Specialisation advocates as the main tool of application of the strategy, especially in its initial phase of design and scoping. Very recently, quantitative analyses have illustrated possible relationships based on relatedness and complexity to reveal trajectories of path creation, useful to set up the EDP. Notwithstanding, EDP is designed and implemented individually by each regional government and few studies have taken into account this perspective. The idea of the paper is to propose an interpretative framework able to capture the nature of EDP, integrating the concept of relatedness, adopted even by proponents of Smart Specialisation Strategy (S3), with the one of entrepreneurial agency. In S3, the idea of relatedness has been studied in association with the structural transformation that occurs within regions and cities through the combination and recombination of different types of knowledge. Nevertheless, relatedness has shown some limitations if blindly applied in the policy framework, without considering the role of entrepreneurial agents in the real process of knowledge transfer. Therefore, the present paper proposes a framework to analyse the EDP, starting with the relatedness approach, useful to detect possible connections (or to exclude dead-end paths) and using the entrepreneurial agency, as a more realistic concept to explain the micro-dynamics that rule EDP.
Accordingly, the second paper aims to answer two RQs:

- *How does relatedness work at different levels of analysis? And what "nuances" emerge at the micro-level?*

[2] Early version presented at the SMARTER conference of 2018, Sevilla, Spain, 28 September 2018.

- What are the mechanisms through which the institutional entrepreneurs identify the bottlenecks and the potentialities of the ecosystem, promoting knowledge exchange and influencing the final outcome of the EDP?

The framework is then applied to the case of Tuscany, using a mixed methodology to inquire the role of the core institutional bridging actors involved in the EDP, the Technological Districts and how they help the Regional Government to set up a "bottom-up" EDP. As a first picture, an original computation of the "Industry Space" of Tuscany is provided using Hidalgo et al. (2007) methodology to detect the main relationships between sectors of Tuscany. Then the Technological Districts' managers are interviewed, as a sort of fact checking with the Industry Space results, to understand how they define their planning strategies and through which mechanisms they integrate knowledge and combine firms and R&D specialities. Results confirm the necessity to integrate the two concepts to obtain a more realistic "policy orientation map", and the broader horizon released by relatedness if deeply analysed with case studies at a micro-level and if directly discussed with some central agents embedded in the regional network of proximities.

Third paper. *Entrepreneurial styles and knowledge integration: meeting the challenges generated by S3 and EDP*[3]

In the last decades, the successful entrepreneurial models were built on a vision based on the accumulation over time of competences, resources and experience, surrounded by the "opportunity smelling" approach and keener on the local thickening of technical and scientific skills. More recently in the complexification of the production processes products have become "multi-technology", "multi-domains" and "multi-functions". The focus has shifted towards an entrepreneurial figure that, beyond these characteristics, is mainly able to integrate different sources of knowledge, in a complementary view with "lower frequency circuits", which occurs in the exchange of knowledge at a global level. These micro examples have been often neglected but represent interesting channels to study new bottom-up policy models. Understanding these entrepreneurial figures, able to integrate different sources of knowledge, can be crucial to stimulate a reflection on the future policy guidelines and instruments for the

[3] Early version presented at the Second International conference on Rethinking Clusters, Padua, 15th May 2019.

whole innovation system, as they constitute fundamental "micro pieces" in the scanning process of future opportunities of regional development. This point has not exhaustively discussed in the literature that crosses entrepreneurship and regional science and more specifically in the one that addresses S3.

The aim of the paper is thus to study a bunch of entrepreneurs as integrators of different sources of knowledge, in the attempt to individuate the emerging properties of these agents and what role they can play in the regional structural change promoted by S3.

The RQs of the third paper are:

- *Can we define specific characteristics of entrepreneurs as knowledge integrators in the current techno-economic scenario?*
- *What are the policy implications for the Entrepreneurial Discovery Process (EDP) within the S3 framework?*

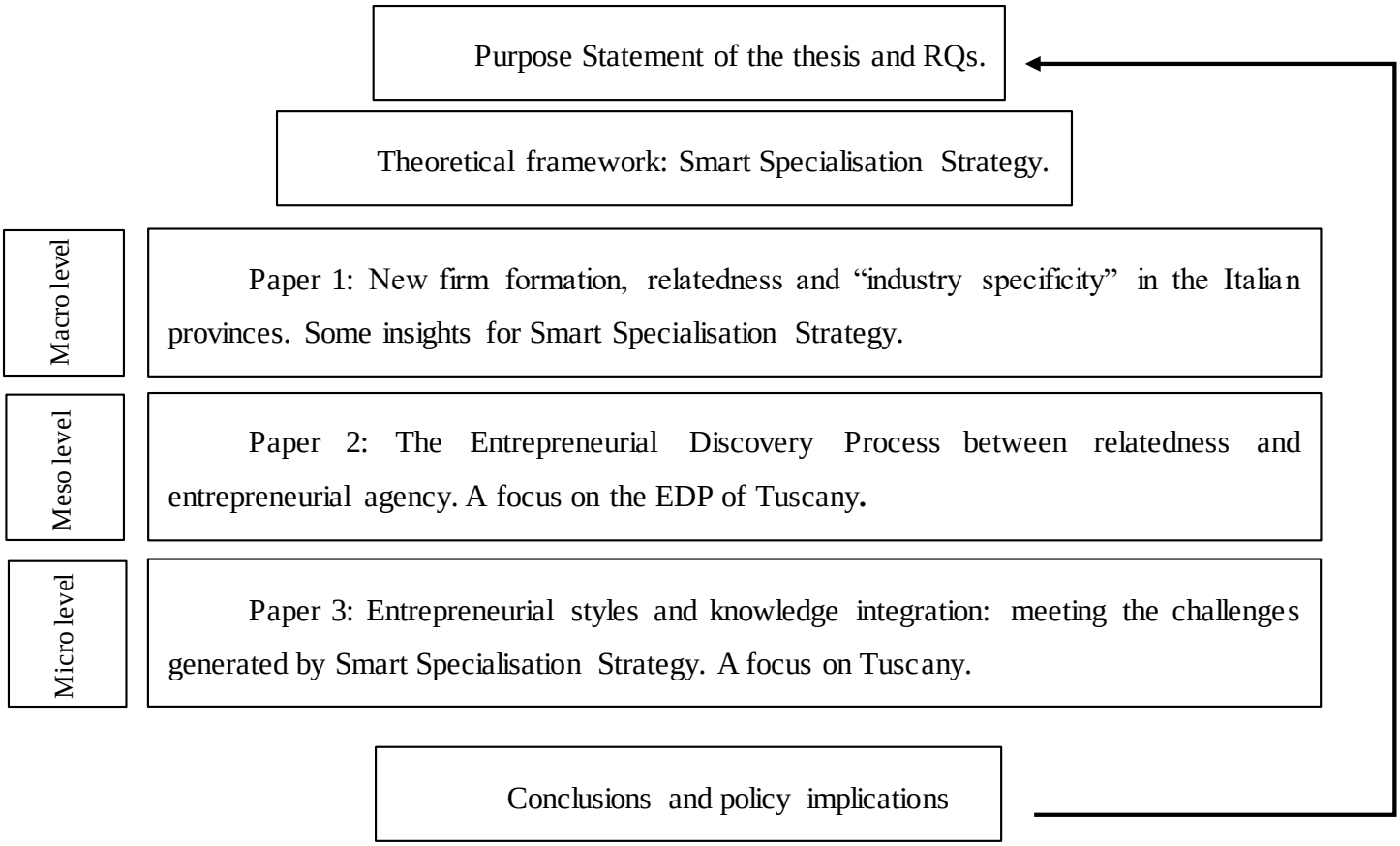
The methodology adopts a qualitative approach, using semi-structured interviews administered to a selected set of entrepreneurs in Tuscany. The sample of the entrepreneurs, selected with a purposeful criterion, has been built thanks to the help of key informants, focusing on the inductive potentiality of data to reinforce a fuzzy theoretical framework. The gathered data are codified with the help of Gioia methodology (Gioia et al., 2012), in order to derive some characteristics of the entrepreneur and the firms to describe emerging properties. Then, a ladder of entrepreneurial typologies, able to group the specific characteristics derived from the interviews, is proposed. Starting from the key messages that emerge by this ladder, it is suggested a "distributed technology transfer model" to include different kind of entrepreneurs in the design and management of EDP (even without praising successful global stories - as the case of Elon Musk). These implications offer a complementary explanation of structural change and the current industrial transformation, actually shifted towards a new cyber-manufacturing regime of production.

Table 1. Summary table of the three papers

Paper	Meaning of relatedness	Meaning of entrepreneurship	Methodology applied	Context
1	Territorial proximity between sectors	New firm formation	Quantitative; econometric model (negative binomial regression)	Italian provinces
2	Combination and integration of knowledge	Institutional entrepreneurship	Mixed; Industry Space methodology and semi-structured interviews	Tuscany
3	Combination and integration of knowledge	Entrepreneurs as knowledge integrators	Qualitative; semi-structured interviews	Tuscany

Source: Author's elaboration

Figure 3. Thesis overview



2. Smart Specialisation Strategy: an introduction

2.1 The birth of Smart Specialisation Strategy, its rationales and distinctive elements

In 2005 the research commissioner of EU J. Potoĉnik created a group of experts in innovation and growth economics called "Knowledge for Growth" (K4G)[4]. The birth of this "K4G" group was promoted by Potoĉnik to support the strategic guidelines of the Lisbon Strategy of 2009, concerning a sustainable growth and prosperity (Foray et al., 2009). The activity of the group was initially concentrated on addressing climate change, health and food issue. Then, shaken by the financial crisis of 2008, the necessity was to face these mega-challenges with a strategy not only focused on the policy instruments, but on the creation of a favourable context for a joint action of the private and public spheres. One of the first narratives proposed by O'Sullivan emphasised the gap between the R&D US and EU systems (€60 billion), considered one of the main symptoms of the weaker capacity to innovate in Europe in comparison to United States (Foray and colleagues, 2009). O'Sullivan underlined that the shortage of investment in Information and Technology (IT) goods and services by EU companies represented one of the most widely difference with US firms, which were more reactive in understanding the occurring digital revolution (Foray and colleagues, 2009). Therefore, the R&D incentives were rightly considered the consequence of the general state of European innovative system.

Some years later, EU with the political Agenda Europe 2020, in line with the work of the K4G group, proposed a strategy where some important priorities were identified as the key target of action (EC, 2010a):

- 75 % of the population aged 20-64 should be employed.
- 3% of the EU's GDP should be invested in R&D (especially the private sector)
- The "20/20/20" climate/energy targets should be met (including an increase to 30% of emissions reduction if the conditions are right).
- The share of early school leavers should be under 10% and at least 40% of the younger generation should have a tertiary degree.
- 20 million less people should be at risk of poverty.

[4] In the annexes the list of the member of the Knowledge for Growth" group is reported.

The idea was to promote within the framework of Cohesion policy 2014-2020 some initiatives aimed at a Smart, Inclusive and Sustainable Growth. The Smart Growth sphere was based on the idea to build an economic system based on knowledge and growth, the Inclusive Growth was concentrated on fostering a high-employment on the principle of social and territorial cohesion and the Sustainable Growth was devoted on a more efficient, greener, but competitive use of resource (EC, 2010a).

The flagship initiative *Innovation Union*, which adopts an "Open Innovation" vision (Chesbrough, 2003), was particularly relevant for the Smart Growth initiative. It included 30 points relevant to make the Europe Innovation system more able to exploit the research potentialities, more agile in providing high-qualified skills and in the patenting activities and more integrated in its public and private spheres (EC, 2010b; EC, 2010c). The *Innovation Union* framework was built on some of the points raised by the K4G, in particular, the transatlantic R&D gap and the *Smart Specialisation Strategy* (Foray et al., 2009; Foray, 2014)[5].

The motivations of the former seeds behind the necessity of an effective turning change in the R&D system as a mechanism for innovation and development, converging on the translation of R&D into concrete effects, removing institutional, legal and cultural barriers, but without emulating successful stories "from the pond" (Foray and Van Ark, 2007; EC, 2010c). The latter, Smart Specialisation Strategy (S3), was the strategic response that Europe put in place to cope with the abovementioned problem. In other words, the capacity of firms and public sector to successfully cooperate in the passage between the invention and the adoption of new technologies to the market side (innovation) was the structural gap, which Europe identified in comparison to the American and Japanese models, considered more efficient (McCann and Ortega-Argilés, 2013; McCann and Ortega-Argilés, 2016).

Dominique Foray, one of the main advocates of the strategy, describes S3 as follows:

"the capacity of an economic system (a region for example) to generate new specialities through the discovery of new domains of opportunity and the local concentration and agglomeration of resources and competences in these domains. Such a capacity is needed to initiate structural changes in the form of diversification, transition, modernisation or the radical foundation of industries and/or services" (Foray, 2015, p.26).

[5] The conceptual origin of S3 was promoted by the K4G group, while the Directorate-General for Regional and Urban Policy (DG REGIO) was responsible in the person of the Commissioner J. Hahn of the enforcement of the strategy in its practical aspects (such as the ex-ante conditionality criteria) between 2011 and 2013, as for other regional policies devoted to R&I since the early nineties (Foray, 2015).

European Union adopted with the European Regulation n°1303/2013[6]a common definition of S3, valid for all the European Region:

"Smart specialisation strategy' means the national or regional innovation strategies which set priorities in order to build competitive advantage by developing and matching research and innovation own strengths to business needs in order to address emerging opportunities and market developments in a coherent manner, while avoiding duplication and fragmentation of efforts; a smart specialisation strategy may take the form of, or be included in, a national or regional research and innovation (R&I) strategic policy framework" (p.19)

These two definitions present some central elements to understand the essence of S3. The first point that could create some confusion is the word "Specialisation", which, according to Foray is not a rehabilitation of Ricardian philosophy, but the orchestrated attempt to trigger structural changes in the regional economy (Foray, 2014; Foray, 2015). Foray (2015) draw the attention on how the two notions of Smart Specialisation and Smart Specialisation Strategy should not be confused. History is full of "Smart Specialisation experiences" that occurred naturally. Foray in his book of 2015 describes some examples. In the region of Morez (in the France-Switzerland border), it was "discovered" the possibility to shift from nail production to spectacles with the already owned competences. This revolution was guided by a man who inspired many others to follow this opportunity. The consequence was the birth of many factories and of a technical school. Other cases are mentioned: Marinha Grande region that saw the passage from glass-making to plastic; the city of Lyon that saw many firms shifting from traditional silk to technical fibres (also for aerospace); the pulp and paper industry upgrading in Finland (with nanotechnology applications).

On the contrary, the concept of strategy adds to the path transformation and/or creation experiences a systemic planning activity by the Regional Government to stimulate this change. For this to be achieved, selective choices must be done considering the constraints of critical mass and potential feasibility (Foray, 2018).

Foray (2015) identifies some common principles to correctly design Smart Specialisation Strategies:

[6] The regulation (EU) 1303/2013 of the European Parliament and of the Council of 17 December 2013 represents the legal base of S3.

1) entrepreneurial discoveries and granularity. Entrepreneurial Discovery is the conscious exploration of the potentialities of the region. It is a bottom-up process of discovery coordinated by the regional government, but actively participated by the regional actors at all levels: firms, R&D centres, universities, associations (Foray, 2014). This process, conducted autonomously by each region, through a series of steps, allows the regional government to identify some common priorities of investment according to the knowledge owned by these actors and their (potential) connections. These priorities should be established in public-private interactive processes of mutual learning at the right level of granularity, neither at a sectoral nor a too micro-level, able to foster the development of collective explorative and experimental experiences (both on the technological and market sides) (Foray and Goneaga, 2013).
2) inclusiveness and the sleeping giant, excited goblins and hungry dwarfs. This principle means giving the chance to every sector to be included in the strategy, obviously considering the different paces and tempo effect of the policy on different actors ("giant", "goblins" and "dwarfs"), which have completely different characteristics, given their structure, history and innovation dynamics (Foray and Goneaga, 2013, Foray, 2015).
3) evolving prioritisation. The priorities identified through the Entrepreneurial Discovery Process do not remain the same forever: after a certain period, these can change, considering the coming of new disruptive technologies (that can substantially lower some costs), the global conditions and the entry/exit of actors from the strategy (Foray, 2015).
4) observation and evaluation. S3 requires ex-ante scanning and on-going monitoring and evaluation. There is the necessity to assess if a priority, identified after the discovery process, is indeed valuable, what are the key regional elements that could be affected by the strategy, observing micro-dynamics together with the preliminary macro analysis is fundamental (Foray and Goneaga, 2013, Foray and Rainoldi, 2013).
5) support of early-stage and growth of new activities. S3 does not come into conflicts with other European and/or national plans dedicated to innovation, or with classic instruments of policy (as tax credit and subsidies). Quite the reverse, S3 benefits from other horizontal measures, (e.g. devoted to innovative firms or start-ups) because these allow the consolidation of the ecosystem of innovation, fundamental to create a critical mass (Foray and Goneaga, 2013, Foray and Rainoldi, 2013).

The policy objectives of S3 develop from the selection of priorities in a vertical and non-neutral view, within which the most promising areas of intervention in terms of technologies, practices, disciplines aim to promote economies of scale and agglomeration (Foray and

Goenaga, 2013). Therefore, the way suggested by S3 should be taken through the development of the knowledge bases held by the region, neither specialising nor diversifying, but adopting a specialised diversification view, able to stimulates the process of regional branching into new activities connected (but not limited) to the existent industrial structure (Asheim et al., 2011; Boschma and Gianelle, 2014). Regions have urgently and seriously tackled the idea of S3, which represents a precondition to obtaining the European Regional Development Funds (ERDF) for the period 2014-2020, from many years a consistent source of public funding to realise regional policies. The purpose of S3 is to push regional entities to use more effectively the funds (avoiding dispersion of investments), concentrating the efforts on the technological domains that link existent local capabilities and strengths to future areas of development in order to favour also an inter-regional and transnational collaboration (Iacobucci and Guzzini, 2016).

S3 originated with the aim to reduce the innovation gap with other global leaders, but many of the concepts and ideas deployed derive from a new stream of industrial policy based on the acknowledgement of a renovated idea of economic development (Barca, 2009).
After the financial crisis of 2008, it has grown the awareness among scholars and pundits that to enforce a structural change, it is not enough providing a set of tools to address the so-called market failures (Rodrik, 2004; Stiglitz et al., 2013). Market failures have been overcome in favour of a typology of intervention aimed to shape and create markets, with a mission-oriented outlook capable to involve a set of different actors across different sectors in a vertical manner (Warwick, 2013; Mazzucato, 2018). Hausmann and Rodrick (2003) underline how the previous policy approaches saw economic development as a simplistic function of technology and institutions' quality, without considering too much the inner capacity, that a country, a region, a city should acknowledge starting a learning process of "self-knowledge". The development of nations, regions, cities is like the development of human bodies, composed by many neurons, muscles, bones all interconnected: promoting a structural change means transfer and create new competences to deal with global uncertainties (Hidalgo and Hausmann, 2008; Rodrik, 2008). Of course, uncertainties are many and frequents and a certain degree of "unknown" remains, given the fact the economic problems are normally projected in the future (Arthur, 2013).

The best that territories can do is stimulating this process of self-knowledge, which in turn allows to diversify their own productive structure and economic capabilities towards the discovery process. This requires the public-private strategic collaboration to help governments to acquire the information necessary to learn what are the major bottlenecks into which

innovation cannot be framed as linear sequence of steps (Rodrik, 2004; Asheim, 2019). Moreover, to enforce this different view, vertical mission-oriented policies, such as S3, need to empower the collective system with a number of fundamental elements such as entrepreneurial culture, stable financial system, education programmes for managers and workers adopting a "network view" of innovation policy (Lall, 2003; Foray, 2018; Sorensen, 2018).

What clearly emerge is that concepts such as the Technological System (Carlsson and Stankiewicz, 1991) Regional Innovation System (Cooke, 1992), National Innovation System (Lundvall, 1992), Techno-Economic Paradigms (Perez, 2010), Business Clusters (Porter, 1990) have all contributed to define the leitmotiv on which current innovation policy are built (as underlined by Uyarra et al., 2017; Marques and Morgan, 2018). S3 does not work in contrast or divergence with these approaches (Foray, 2015), but explicitly introduces the element of discovery as a cornerstone of the strategy. In the light of all the above, the process with which regions establish priorities, the EDP, deserves a further deepening for its degree of novelty in comparison to the previous policy approaches and given the scarcity of the literature on its theoretical aspects (see Aranguren et al., 2019).

2.2 A deeper look into The Entrepreneurial Discovery Process: from the rationales to the pieces of the theoretical puzzle

The EDP has been defined as the key tool to implement the principles of S3 of structural change. Foray extensively describes the various characteristics and nuances of EDP in his contributions to S3. First of all, he underlines how the immediate adoption of EDP as a policy tool is occurring during the "development of its theoretical framework" by the actors involved, justifying possible misunderstanding respect to the original purpose of the tool. For instance, he explicitly distinguishes the concept of EDP from the idea of entrepreneurial innovation, stressing that EDP adds the instilling of innovative mindsets and ideas in a broader context, namely the areas that can be useful to trace possible trajectories of change (Foray, 2015). Accordingly, the previous policy approach and tools were conceived in a more top-down and linear logic: the policymakers know the context and, collecting relevant information, can provide those incentives that solve the classical issues of market failures and externalities.
The process of discovery instead assumes that this knowledge is dispersed and therefore the engagement of the actors of the ecosystem is crucial to compensate its asymmetric character. In this sense "discovery" should be intended as much as possible as a natural bottom-up process,

in which the role of the policymakers is to empower the actors, trying to avoid "dead-end" paths (Foray et al., 2009). Referring to this, it is also important that this process combines the local entrepreneurial knowledge, owned by firm entrepreneurs, research leaders, inventors and innovators with a systemic and long-term view of innovative change (Foray and Goneaga, 2013). Moreover, the activities to be prioritised should be the ones able to transversally go through a variety of sectors and/or systems and/or technologies, enhancing the combinatorial aspects of the various types of knowledge (as scientific and economical) (Foray and Goneaga, 2013). The final aim of EDP is to generate relevant information for the system, promoting a realistic strategy, based on what the process itself has revealed, possibly evidencing not only the known actors and channels to be combined, but also giving support for the knowledge that in a first phase can be hidden or dispersed (Foray, 2016).

Therefore, as some studies point out (McCann and Ortega-Argilés, 2013; OECD, 2013), EDP is not a new concept, because the "*notion of a market as a 'discovery process' rather than as an efficient mechanism for allocation of scarce resources"* (Nooteboom and Stam, 2008, p.31) has pushed economists since several decades ago to question the idea omniscient planner in favour to a vision of distributed (and often disconnected) channels of knowledge.

Starting with the idea that information asymmetry covers a central role in policy design, the same Foray (2016) refers to the contribution of Hayek traced back to 1945. In the paper *"The Use of Knowledge in Society",* Hayek states that utilisation of knowledge, own by diverse parts of the society, is one of the main big problems that economic theory (at that time) seemed to neglect. Hayek brings the concrete example of planning or setting a strategy as very dependent on the issue of knowledge possession (who possesses it, at what time he/she has the information). In addition, the author presents the importance of "*circumstances of time and place"*, pieces of knowledge that should whatsoever be combined beyond the restricted perspective of the individual, who, notwithstanding, can transfer to the decision-makers important information, that in other instances could be only hypothesised. This perspective in a logic of EDP is enriched by Hirschman (1958), who offers an interesting perspective on economic development very adaptable to the principles of EDP: *"development 'depends not so much on finding optimal combinations for given resources and factors of production as on calling forth and enlisting for development purposes resources and abilities that are hidden, scattered, or badly utilized"* (Hirschman, 1958, p.5). This thought could be considered as complementary to the view taken by Hayek, because the idea of hidden knowledge (to the central planner) confirms that promoting a promising path of economic development is a matter

of cooperation and coordination more than taking optimal decisions, that for several reasons remains optimal only in theory. Another perspective, useful to understand the theoretical roots of EDP, is the one that came from Schumpeter. Schumpeter (1934) in the second chapter *("The fundamental phenomenon of Economic development"*) of his famous work "*Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle",* points out that "*to produce means to combine materials and forces within our reach. To produce other things, or the same things by a different method, means to combine these materials and forces differently"* (Schumpeter, 1934, p.70).

This thinking reveals how important is the emergence of new combinations for the economic development, which the same Schumpeter, as a brilliant trailblazer, defines non-linear and discontinuous. This reflection develops in the eighties since the pioneering work by Nelson and Winter (1982), converging to the evolutionary economic geography approach. If the contribution of Hayek and in part of Hirschman are more useful to comprehend the mechanism of information asymmetry and dispersion of knowledge, the argument of Schumpeter is crucial to frame EDP as a heuristic and continuous pattern of discovery[7]. This heuristic pattern seeds at the very basis of EDP and can be defined as a "*conscious experimentation*" framework (Zysman and Brie, 2004). Experiments are conducted to improve the economic system, following precise criteria of exploration, through advancement in technology, business models and social values, addressed by the wide range of entrepreneurial actors.

Within these coordinates, the fundamental contribution of Herbert Simon on the "construction of problem spaces" is coherent to frame a scenario into which human attempt to define, systematise problem structure is for the most an "illusion" that mix reality with idealisation of problems and successful strategies (Simon and Newell, 1971; Simon, 1973). What lacks is the acknowledgment that the major part of current economic problems is intrinsically ill-defined, because the "collision" of complex environments increase the unpredictability of the system (Simon, 1973; Dennet, 1996). The theory of experimentally organised economy and competence blocs by Johansson (2010) goes towards this direction, where the fragmented blocs are defined as the *"total infrastructure*" contributing to the process of "*creative experimentation*" (in the phase of creation, selection, recognition, diffusion and

[7] Nelson and Winter (1977, p.52) define a heuristic search process as "*an activity that has a goal, and a set of procedures for identifying, screening, and homing in on promising ways to get to that objective or close to it*".

exploitation). In that vision each firm is seen as a *"market experiment*" or *"business hypothesis"* and new knowledge is estimated trough this mechanism (Johansson, 2010). A similar attempt is proposed by Hekkert et al. (2007), who try to map the innovation systems in various phases, namely: creation of new knowledge, guide of the direction of the search process, supply of the resources, support to the formation of positive external economies (e.g. exchange of information, knowledge, and visions) and assistance to the formation of markets. It appears how the entrepreneurs and the creation of knowledge are integrated into a single framework where mechanisms such as market relationships, cooperation between actors, mobilisation of resources are fundamental to the realisation of the entrepreneurial experimentation, which occurred through knowledge spillovers. These phases give a practical example of how conscious explorations could be structured, making clear that to orchestrate the EDP a systemic view should be embraced. For instance, the "entrepreneurial properties" of the network of agents and the institutions relative to the same bloc (following Johansson, 2010) are, with other blocs, part of a broader and complex system (Carlsson and Stankiewicz, 1991). When referring to the entrepreneurial properties of actors, the field of entrepreneurship studies gives an important contribution. Kirzner (1997) delves explicitly with the concept of entrepreneurial discovery, explaining the difference between discovery and search, expressing it in the capacity of the former to be a process that provokes surprise and can include errors, finding a very well fit in the trial and error approach and ongoing process stated by Foray in the EDP basic principles.

The term discovery is a cornerstone of the entrepreneurial mind-set (Fiet, 1996), which sets at the basics of the "value creation process" that some authors have explained as made of vision, contingent knowledge, previous experience, and decision-making (leadership) (González-Cruz and Devece, 2018). Particularly the "smell of opportunities" (the alertness, see Kirzner, 2009) can be an unexpected outcome, obtained precisely because different actors have different perspectives, which can lead to different scenarios (Cuervo et al., 2007). Of course, the opportunity recognition should be followed by the opportunity development (Ardichvili et al., 2003), understandable as the scale-up phases of a start-up, crucial to really go from the potential idea to its real application.

As a final stream of literature necessary to deeply comprehend the EDP, the role of institutions is surely fundamental to "lubricate" the functioning of the process. Institutions are crucial for the effectiveness of the process, especially to help SMEs to solve the incomplete appropriability problem: the lack of resources makes inconvenient to the firms, in the major

part of the cases, to pursue the exploratory approach (Rodríguez-Pose and Wilkie, 2015). In the actual context of post-recovery from the economic crisis, entrepreneurs solely can evaluate new activities as too risky and with low initial profits, therefore a collaborative leadership of institutions can nurture the experimental phases (Rodrik, 2004). The presence (or absence of knowledge) is perceived in the so-called issues of "connectivity", meant as the interaction between the helices of the ecosystem within regions (Virkkala et al., 2017) and even between regions (Iacobucci and Guzzini, 2016). The experience of EDP in European regions has led some scholars to assert that it does not happen mechanically nor spontaneously (Rodríguez-Pose and Wilkie, 2015), and the lack of the regional connectivity among the spheres of the ecosystem can slow down the process (Aranguren et al., 2019).

To this extent, a good stakeholder engagement in the EDP requires institutions able to communicate "the sense" of strategy and the results to the society, with transparent programmes (OECD, 2013; Gianelle et al., 2016) and the involvement of the "right actors" in the process (Kogler and Whittle, 2018). Moreover, some scholars have underlined how also the quality of governments need to be seriously addressed when EDP is analysed, including the "politics" in the discussion of innovation to understand the real impacts of these kinds of policies (Rodríguez-Pose and Wilkie, 2015; Marques and Morgan, 2018).

3. New firm formation, relatedness and "industry specificity" in the Italian provinces. Some insights for Smart Specialisation Strategy

3.1. Introduction

The idea that entrepreneurship is a fundamental engine of economic development has been deeply analysed in many studies, evidencing how the role of the entrepreneur is to contribute to the economic growth of cities and regions (Baumol, 2011; Feldman and Avnimelech, 2011).

The entrepreneurship dynamics, particularly in its "discovery denotation" (Shane, 2000), can contribute to the economic development of a territory through new combinations of knowledge and resources, which originate from a heuristic process of diversification into new activities by incumbents (Breschi et al., 2003) and/or from the creation of new firms (Rocha, 2013). The second mechanism, the establishment of new firms, seems particularly relevant to explain how knowledge spillovers favour economic growth, thanks to the capacity of new firms to break through with new ideas/market opportunities left by existent organisations (Kirzner, 2009).

The successful entrepreneurial actors who live in the territorial ecosystem, embedded in a given industrial structure, are able to translate and interpret this existent knowledge in a recombinant view (Antonelli et al., 2010), commercialising new products, hence giving room for the births of new firms (Qian and Acs, 2013). Therefore, new firms represent a channel between the (sometimes "hidden") knowledge owned by a territory, but not already exploited by incumbents (Qian et al., 2012; Audretsch et al., 2015).

Referring to this point, cross-fertilisation dynamics have been studied as important determinants of innovation in new businesses and their growth (Antonietti and Gambarotto, 2018; Innocenti and Zampi, 2019), and the combination of different type of knowledge has revealed unknown connections, especially in the creative sectors (Lazzeretti et al., 2017; Innocenti and Lazzeretti, 2019a). Although the formation of new businesses can be central to understand the mechanism by which local knowledge is transformed and recombined into innovative activities, the relationship between firm formation and knowledge recombination is still little explained and the debate remains an open issue.

Among the principles of S3, there is the need to detect the connection between new entrepreneurship and related or unrelated domains of knowledge in a logic of future path

creation (Foray, 2015). Accordingly, Dominique Foray, one of the main advocates of S3, pointed out how the aim of the strategy is not to tell to the regional governments what industries should be financed to promote a growth path, but to do a recon on the current of regional strengths and the possibilities linked to the existent "knowledge bases" (Colombelli, 2016).

Remembering the epoch-making case of Detroit, the process of regional branching is assuming more and more importance to avoid impasse and promote an economic path able to successfully expand, modernise and/or renew the current economic productive structure. Aware of this, Xiao et al. (2018) underline how industrial diversification is what European regions are looking for, nevertheless leaving room for the debate on related or unrelated diversification, brought to a wide audience by the work of Frenken et al. (2007). Some recent studies have highlighted that new firm formation can be a determinant of regional branching and thus the comprehension of its dynamics in relation to the existent territorial knowledge is a captivating argument in the S3 logic (Content and Frenken, 2016).

Borrás and Jordana (2016, p. 2136) shed light on this point, underlining that: "*Smart specialisation is the spontaneous outcome of entrepreneurial discovery, a combination of different knowledge sources, spillovers in the form of entry and agglomeration of firms, and subsequent structural change".* Accordingly, analyses concerning entrepreneurship in relation to S3 were recently developed. Among others, Colombelli and Quatraro (2018) with the Knowledge Spillover Theory of Entrepreneurship (KSTE) and Neffke et al. (2018) analyse the role of entrepreneurs as agents of structural changes in regional economies.

Bearing in mind the aspects that link firm start-up and existent knowledge base, this work goes in the direction recommended by Boschma and Gianelle (2014), linking entrepreneurship theories with relatedness studies, to advance the comprehension of how entrepreneurship, as a combinatory activity relied on the existent industrial structure, can be explicitly inserted in the S3 framework.

The aim of this chapter is to contribute to the understanding of the specific relation between the creation of new firms and the proximity to an existent local industrial base, following a line of studies that mixes entrepreneurship and relatedness approach, shedding lights on the effects of this relation on S3 (Knoben et al, 2011; Bishop, 2012; Colombelli, 2016; Howell, 2017; Antonietti and Gambarotto, 2018; Colombelli and Quatraro, 2018; He et al., 2018). The present analysis follows the stream on the "agnostic relatedness", which allows to map the level of proximity, without assuming a preliminary framework of related and unrelated relationships (Hidalgo et al., 2007; Innocenti and Lazzeretti, 2019b).

However, in comparison to the majority of studies that follows this approach, this work does not look at the effect of "general relatedness" (between all the industrial sectors) on the overall rate of new firm creation. The idea, taking the cue from Bishop and Gripaios (2010), is to decompose new firm formation and relatedness measures by industries, to test if and how the "specificity" of firm natality is driven by the level of external or internal relatedness. To evaluate this relationship, various econometric models are estimated, one for each industrial sector considered in the analysis (27 among manufacturing and KIBS industries), using the number of new firms born in the Italian provinces in the period 2012-2014 from the MOVIMPRESE database. The measures of internal and external relatedness are calculated using the Product Space methodology developed by Hidalgo et al. (2007).

The work is organised as follows. In the second section there is a literature review on the two main subjects of the analysis, firstly concerning new firm formation and regional development and after on the studies that deal with relatedness and regional development. Then it is presented a review of the works that combine the two perspectives. In the third section, the motivations and the aim of the work are presented in detail. The fourth section illustrates the research design, describing the data, the variables and the econometric strategy employed in the study. The fifth section presents the results of the analysis. The sixth section discusses the findings, pointing out connections and differences with previous studies on this topic. The last section exacerbates some first conclusion and policy implications for the S3.

3.2. Theoretical background: new firm formation and the role of knowledge proximity at a local level

3.2.1. Entrepreneurship as new firm formation

In regional studies, entrepreneurship has been analysed not only as a result of regional factors but also as a determinant of regional growth (Stuetzer et al., 2018). Within the entrepreneurship literature, the birth of new firms has received since the nineties a growing attention in relation to the topic of regional growth[8]. If until the eighties, the process of new

[8] Garofoli (1992) enumerates three theoretical streams to which these kinds of studies refer. The first is the *incubator hypothesis*, which sees the existence of urban areas as "nursery" of the ideas and facilitators for the proximities of different type of activities. The second is the *filtering down theory,* which looks at products and

firm formation was largely explained as a consequence of unemployment dynamics (Armington and Acs, 2002), afterwards an increasing number of researches has tried to find evidence of the effects of new firm rate on the regional prosperity (Massón-Guerra and Ortín-Ángel, 2017). Inferring on the impact of new firm on regional growth can be misleading, without considering the general conditions of the ecosystem (see Capello and Lenzi, 2016) and an increasing number of start-ups can represent an indicator of a trajectory of growth already taken (Fritsch, 2013)[9]. Accordingly, the augmented level of competitiveness, the pressure on the incumbents and the spillovers that can occur even out from the start-up birth sector are important factors that need to be taken into account (Fritsch, 2008; Van Stel and Suddle, 2008). Among the other context variables that have been examined in relation to new firm formation, there is the role of clusters (Koo and Cho, 2011) and the incubator function of industrial district (Audretsch and Vivarelli, 1996), even if there are few studies who address this specific theme.

Some works have tried to demonstrate the impact of new firm formation on employment growth (as a proxy of regional prosperity), finding that this effect is not obvious and can be influenced by the "*sectoral structur*e" (Davidson et al., 1994; Fritsch, 1997; Mueller et al., 2008). Analyses were conducted across western countries and regions, with scarce attention to low-income countries that could reveal different patterns. The research of Reynolds et al. (1994) concludes that new firm formation process seems to be uniform at least for advanced economies, while following studies find significant differences in European economies especially in the timing of their subsequent impact on employment growth and its quality (Baptista et al., 2008; Van Stel and Suddle, 2008).

Referred to this last point, the idea that new firm formation has maintained different levels among European countries was figured out with the help of path dependency trajectories (Fotopoulos, 2014), addressing the topic of old industrial regions (Hedfeldt and Lundmark, 2015), and the capacity to be resilient respect to economic crises (Bishop and Shilcof, 2017; Bishop, 2018). Another stream of research tries to conceive the various aspects of new firm formation in a multilevel framework with the aim to explain individual choices to start an activity on the basis of time and space (Hundt and Sternberg, 2016), considering also the extra local sources of inspiration (Martynovich, 2017).

industry life cycle as determinants of innovative new firms. The third is the *seed bed growth hypothesis*, which states that the industrial structure operating by spin-off facilitates the birth of new firms.

[9] However, the debate remains still open, as underlined by Mueller et al. (2008), who claim that "*new firm formation causes increased employment and not vice versa*"

The literature abovementioned has identified entrepreneurship, as the creation of new businesses, among the crucial factors to analyse, in the attempt to comprehend the economic conditions of regions. However, making a step backward, it remains open the issue of the role of knowledge in the process of new entrepreneurship. Carlsson et al (2009) argue that there is an economically useful knowledge (of various types) converted by entrepreneurship in economic activities that can lead to economic growth.

In this framework new firms are particularly able to potentiate the innovation capacity of a region (Falck, 2007), exploiting the fact that some competences and forms of knowledge are already expressed by the territory and combined and recombined in new ways by these new entrepreneurial agents (Rocha, 2013; Fritsch and Kublina, 2018).

Henning and McKelvey (2018) state that to understand the role of knowledge in the process of entrepreneurship is a fundamental point that would enable the various spheres of the society (policymakers, entrepreneurs, universities, civilians) to address an economic development deployed towards an idea of human progress.

Before to address the specific issue of the influence of knowledge on new firm formation is important to introduce the role of knowledge (and its combination) in the context of economic production.

3.2.2 Proximity and combination of knowledge: the idea of relatedness

The concept of knowledge has been analysed by very well-known scholars in relation to the economic system (Hayek, 1945; Arrow, 1962) and more recently with the introduction of the evolutionary and complex character of it (Nelson and Winter, 1982; Eliasson et al., 1990).

For what concerns the productive sphere, especially technological knowledge has been the object of the analyses of many studies, which have generally underlined the cumulative and combinatorial aspects of knowledge (Arthur, 2009). Hence, it is not only the amount of certain types of knowledge owned by a region or a country that determine its development. The greater connectivity of economic systems (thanks to the digital transformation) and the interactions of different agents at a local/global scale recombine have created an enormous space of possibilities, favouring the creation of new knowledge (Antonelli, 2003; Carlsson, 2004).

In the last decades, with the progressive complexification of the production process (from a scientific and technical point of view) this combinatorial aspect of knowledge (already treated by Schumpeter in its book of 1934, "*The Theory of Economic Development: An Inquiry into*

Profits, Capital, Credit, Interest, and the Business Cycle") has been underlined in studies that try to link regional development and entrepreneurship (Schumpeter, 1934).

This combinatorial and modular view of knowledge finds a fitted application from a theoretical and methodological point of view in the idea of "relatedness". Relatedness is a powerful concept that since a while is gaining more and more consensus for its ability to explain economic phenomena. As people do actions and elaborate thoughts that in whatever manner have links with their previous knowledge or values, the same do firms and broadly speaking the regions and nations in their evolution path[10]. At the firm level, this process has been investigated by leading scholars that contribute to extend the economic knowledge on the coherence of firm activities (Teece et al. 1994) and on the technological distance between firms (Jaffe, 1986; Breschi et al., 2003; Nesta and Saviotti, 2005).

Frenken et al. (2007) underline with a seminal paper how the concept of related variety and unrelated variety differently act on regional development. More recently some empirical measurements of these phenomena have seen the application to the variety between and within sectors to explain regional growth in terms of employment and productivity, most of them focused on related variety (Frenken at a., 2007; Boschma and Iammarino 2009; Boschma et al., 2013). In the last 10 years the idea of related variety has been enlarged to the one of regional branching, explainable chiefly with the capacity of diversification among technologies, production processes, activities, or more broadly knowledge bases, with a high degree of connection respect to the ones already established on the regional/local context (Boschma, 2017). There are several mechanisms that drive relatedness, as producers-users relationship, technological complementarity of different production processes and the costs to start from scratch the establishment of firms in new sectors (Boschma and Frenken, 2009; Boschma et al., 2014). Many studies have tried to measure the effect of relatedness on regional development, starting from the Product Space of Hidalgo et al., (2007), the skills relatedness of Neffke and Henning (2013), the product portfolios of plants (Neffke et al., 2011[11]), the impact of knowledge in cities (Rigby, 2015; Essletzbichler, 2015), the technological complexity (Balland et al., 2018), just to name a few. These approaches have expanded the importance of relatedness "between" categories, following the theoretical principle that proximity levels measured only

[10] Concerning this point, Balland (2016) claims that relatedness adopts an historical lens to look at evolution of territories in terms of innovation.

[11] As stated by the authors there is a substantial difference between their approach and the one of Teece et al. (1994), because the economies of scope are better identified at a plant level.

within two-digit classification can neglect the importance of cross-fertilisation of cognitive domains apparently distant, more frequent with the current incessant technological dynamics (Innocenti and lazzeretti, 2019a; Innocenti and lazzeretti, 2019b).

These kinds of measurements have allowed to enlarge the non-linear approach in applied economics (Balland, 2016), under which innovation dynamics are more realistically framed.

Beyond the recent empirical application, the concept of relatedness has captured the attention of policymakers, who see spinoffs, labour mobility (even intra sectors) and social networking as powerful policy tools to promote this idea of development (Tanner, 2014). There is, however, the consciousness that relatedness can be of less value for strategies that pursue a "creative destruction approach" (Xiao et al., 2018). As a result, a research avenue is open to understand more profoundly the nature, the factors and the regional different drivers of relatedness (Boschma, 2017).

3.2.3 How relatedness impacts new firm formation?

The influence that the local compresence of different types of knowledge has on new firm formation is a topic still to be explored and that is attracting more and more scholars (Capozza et al., 2018). If the Schumpeterian idea of entrepreneurship as disruptive and innovative force is nowadays consolidated (at least at a theoretical level), the relationship that links the creation of a new firm and the existent compresence of different bits of knowledge at a local level is so far in an "opening Pandora box" phase. Accordingly, the "combine and recombine" Schumpeterian approach and the Spillover theory derived from Marshall have raised many questions, even in relation to the one that starts the subsection: how relatedness impacts new firm formation?

The idea that economic development can be reached through new and multiple combinatorial patterns (Weitzman, 1998), in which the uncertainty plays a crucial role in the building of them (Fleming, 2001) is a thought-provoking idea for many researchers. One of the main roads taken to inquire the consequences of relatedness on the birth of new firms is the "spillover effect" within the same industry and between different industries[12].

[12] A concept theoretically explained respectively by Marshallian external economies and Jacobs externalities and then tested by several studies (among all Glaeser et al., 1992 and Henderson et al., 1995).

The standard approach that frames this relationship states that the (still unexploited) knowledge embedded in a territory can propagate ("spills over") and be appropriated by agents that found new activities (Rocha, 2013). These agents have the ability to transform and combine different sources of knowledge, according to their background, their skills, their aptitudes and collaborating with other people (Acs et al., 2009, Grillitsch, 2019). The reflection, therefore, develops in a double direction: knowledge, except from the one embedded in patents, moves freely between actors at various scale. In this process, the new firm, as a conduit of this unexpressed knowledge, acquires fundamental importance to explain the knowledge evolution dynamics into regional contexts (Ghio et al., 2015). Some studies have focused their attention on services, identifying, in particular, the Knowledge Intensive Business Sectors (KIBS) as remarkable areas of knowledge combination and transformation, studying the role of multinational (Jacobs et al., 2014) and local manufacturing (Wyrwich, 2019). A clear example of the configuration of new knowledge space is represented by the spinoff of experienced workers, who are able to adapt their previous knowledge in different contexts, exploiting a determinant scarce information or successfully anticipating a trend (Klepper, 2007; Renski, 2014).

Until recently, the analyses on knowledge generation and diffusion within territories were mainly based on general elements such as R&D expenses by private firms, stock of scientific and technical experts (e.g., n° of degree in STEM disciplines), role of the universities as catalysator of competences and gatekeepers of knowledge. Nevertheless, technical and scientific knowledge alone are neither enough to explain the linkages between territories and knowledge diffusion, nor to explain the ability of firms to survive or excel. The absorptive capacity of complex types of knowledge and the "market knowledge" in terms of business models, the formal and informal relationships with suppliers and customers remain crucial (Bae and Koo, 2008; Andersson and Hellerstedt, 2009; Qian and Jung, 2017).

This idea has been explicitly expressed by the work on the KSTE (Audretsch, 2005) that basically explains how, in the process above mentioned, a new firm represents the canal between the knowledge embedded in a territory but not already exploited by incumbents (Audretsch et al., 2015). The idea that the "richness" of the context provides an incentive for the creation of new firms has been approached considering the impact of diversity, human capital, entrepreneurial culture, and financial conditions, framing KSTE with an ecosystem approach (Lee et al., 2004; Qian et al., 2012; Bishop and Brand, 2014; Qian, 2018).

The concept of KSTE has been further developed, with a geographical approach which has explicitly integrated the theme of entrepreneurship with knowledge agglomeration externalities (Van Oort et al., 2004; Bosma et al., 2008; Knoben et al., 2011).
However, the studies on new firm formation and relatedness, considers also the performance of new firms (in terms of success or failure) and how the portfolio theory applied to regional economies (Frenken et al., 2007) can contribute, together with localisation factors to explain the survival of firms in diverse contexts, as the Chinese one (see Guo et al., 2018; Howell et al., 2018) and the Italian one (Basile et al., 2017).
Some studies have inquired the role of local knowledge, pointing out the role of relatedness for the formation of new businesses, since new entrants can exploit opportunities linked to already existent business or market needs (Bae and Koo, 2008). Accordingly, Colombelli and Quatraro are trying to integrate the KSTE and the recombinant approach in the attempt to understand the relation between the birth of firms the local knowledge base, claiming for the importance of accumulated knowledge in a context (as the Italian one) where small firms blossom (Colombelli and Quatraro, 2013). They individuate the local knowledge stock and its configuration as central properties to define the fertility of an entrepreneurial ecosystem for innovative startups (Colmbelli, 2016), new firms (Colombelli and Quatraro, 2018) and new firms across the macro Pavitt's categories (Colombelli et al., 2019). Other empirical investigations have inquired the effects of unrelated or related variety on startups (Antonietti and Gambarotto, 2018), focusing on the effect of local knowledge stock on green startups (Colombelli and Quatrarto, 2017).

3.3 Motivation and aim of the work

The influence of the different knowledge proximity levels (which configures in the local knowledge structure) on new firm formation counts very few studies, in particular addressing the specific issue of relatedness.
Following previous studies on the topic, this work aims to contribute to the debate on the importance of local knowledge combination in favouring entrepreneurship (Colombelli, 2016; Corradini, 2017; Colombelli and Quatraro, 2018). New firms, beyond their assumed innovative character, constitute one of the mechanisms of path creation at a regional level: a number of new firms of the same sector concentrated in the same area means that in a whatsoever manner

they are shaping at least a piece of the regional economic structure. The mechanisms of KSTE (Plummer and Acs, 2014; Colombelli and Quatraro, 2018) allow to explain the relationship between new firm formation and relatedness of knowledge configuration of territories in the process of regional branching, addressing specifically the relationship between new entrepreneurship and relatedness, in the framework of S3. Entrepreneurship has been identified as a potential key topic in S3 (Boschma et al., 2013; McCann and Ortega-Argilés, 2016) as well related variety for regional transformation (Foray, 2015). Some studies evidence that linking the literature of relatedness with the one of entrepreneurship could produce a valuable comprehension of the effects of S3 on economic development (Boschma and Gianelle, 2014). Following this line, Antonietti and Gambarotto (2018) support the thesis that the main tool of S3, Entrepreneurial Discovery Process (EDP), is based on this principle of regional branching and knowledge spillover, mechanisms that need further tests especially in their effect on new firm formation. Colombelli and Quatraro (2018) point out how the European Union, in designing S3, is very interested in enhancing regional growth trajectories based on the capacity of regional industrial structure to diversify and discover new opportunities, represented also by the creation of new firm. Precedent studies on the topic have associated relatedness more frequently with the employment growth, productivity levels, patent production, with a minor focus on the role of entrepreneurship (Qian et al., 2012; Content and Frenken, 2016).

Moreover, the major part of these studies has investigated relatedness at an overall level without decomposing its components, the internal within sectors and the revealed part that "ignore" the ex-ante statistical taxonomy, and without splitting the analysis by sector.

The risk is to underestimate that industrial sectors may rely on different knowledge bases, leading to different policy conclusions (Davidsson et al., 1994; Bishop and Gripaios, 2010, Colombelli, 2016).

Given the motivation abovementioned, the work aims to inquire the role of different types of relatedness in the process of new firm creation, analysing how this relation work across industrial sectors. The main research question that this work intends to address is:

- Do different types of sectoral relatedness influence new firms' creation across industrial sectors?

This question is broken down into two different hypotheses to test. The first wants to test the impact of *external relatedness*, intended as a measure of "*outside* relatedness" between a

major industrial sector and all the other major industrial sectors. The second aims to verify the impact of *internal relatedness*, a measure of relatedness *within* the same major industrial sector. The former, looking for outward proximity linkages, is supposed to have a wide general impact on new firm formation across sectors, while the latter, measuring only internal synergies, is supposed to follow more different sectoral patterns.

3.4. Research design

3.4.1. Data

The present study refers to 105 Italian provinces[13] classified according to the NUTS-3 taxonomy of the European Union and to 27 industrial sectors at the two-digit level, in manufacturing (NACE Rev.2 codes 10-33)[14] and Knowledge Intensive Business Service (KIBS)[15] (NACE Rev.2 codes 62-63 and 70-74[16]). The database used for the analysis mainly relies on three sources. The data on new and existent firms are taken by the MOVIMPRESE database, provided by the Union of the Italian Chambers of Commerce (Unioncamere). The data taken into account consider registration of new firms[17] and the number of active firms (used as control variables, divided by two-digit sector per each province, from the year 2012 to 2014. The other main source is the Italian National Institute of Statistics (ISTAT), precisely the 2011 Industry Census, which has been used to harvest data to compute the relatedness measures,

[13] The total number of Italian provinces is 110. Five provinces are excluded from this study because of their absence from the MOVIMPRESE database in the timeframe of the analysis. These provinces are Barletta-Andria-Trani, Olbia-Tempio, Ogliastra, Medio Campidano and Carbonia-Iglesias.

[14] Sectors 11,12,19,21 are excluded in this study because of the very limited firms' birth in the period considered.

[15] Regarding KIBS taxonomy is not unanimity. Some scholars propose the codes 62-63 and 69-73 (Schnabl and Zenker, 2013), while others focus on 72-74 (Muller and Doloreux, 2009)., Iin the present study we adopt a wider perspective on KIBS considering NACE Rev.2 codes 62-63 and 69-74, evaluating the ICT, the professional and creative components (Miles, 2011).

[16] Sector 69 is excluded because of the internal relatedness measures would be biased by the fact that this two-digit sector is composed only by two sectors at the four-digit level.

[17] From this database are excluded the small entrepreneurs or businesses based only on the workforce of the family proprietors, allowing to separate from the effect of necessity entrepreneurship, as suggested by the study of Colombelli et al. (2016).

extrapolating employment data at four-digit level and to calculate the control variables used in the model. The last source is EUROSTAT used to compute the Patent Stock for each province in year 2011.

3.4.2. Dependent variables

The economic literature that studies new firm formation argues that the variable to inquire this phenomenon is not a neutral assumption (Audretsch and Fritsch, 1994). Two approaches have been generally taken on to solve the issue: the ecological approach and the local labour market approach (Garofoli, 1992; Audretsch and Fritsch, 1994; Knoben et al., 2011). The first method, mainly employed in the industrial ecological analysis, uses new firm formation divided by the existent stock of firms, while the second divides the number of new firms by the working population. There is more theoretical support for the latter, as it includes the choice of a worker to be an employee or to run a business and the cross mobility of workers, allowing to test better the KSTE (Knoben et al., 2011).

Recently a third methodological approach seems to emerge, applying the simple number of new firm at time *t* as the variable to inquire, claiming that in the local context the number of new firms can be understood as a count data, controlling for the population density, the incumbent's density and/or the employment dynamics (see Audretsch and Lehmann, 2005; Fritsch and Falck, 2007; Bonaccorsi et al., 2013; Colombelli and Quatraro, 2018). In the present work, the idea is to study the relationship between sectoral relatedness and new entrepreneurial dynamics following the latter approach, therefore using new firms as a count variable. We used the number of new firms registered in the period 2012-2014 for each of the 27 two-digit sectors in the manufacturing and KIBS industries included in the study. We decide to use a three-year period, following a robustness check as proposed by Bonaccorsi et. al. (2013), instead of a single year in order to reduce business cycles variation, which can affect the estimation results (Knoben et al., 2011; Bishop, 2012).

3.4.3. Independent variables

As explained in section 2.4, the idea of this work is to test the properties of sectoral proximity in the formation of new firms. The two main independent variables, *internal and*

external relatedness, derive from the application of the methodology used to build the Product Space (Hidalgo et al., 2007) to employees (Innocenti and Lazzeretti, 2019a). This methodology allows to create a symmetric matrix of the 'distances' between the different industries, using an agnostic point of view. The building procedure of the matrix works as follows. Firstly, employment data at the four-digit level (562 industries were considered) have been harvested from ISTAT Census of 2011 for all the Italian provinces considered and a matrix was created according to the Balassa formula of Relative Comparative Advantage (RCA) (see below).

$$RCA(c,i) = \frac{\frac{x(c,i)}{\sum_{i} x(c,i)}}{\frac{\sum_{c} x(c,i)}{\sum_{i,c} x(c,i)}}$$

An adjacency matrix (0-1 values) was obtained, where provinces with a value of 1 in the industry "i" has a comparative advantage respect to the other provinces in the number of employees of the same industry "i". The provinces/industries matrix was then converted to a symmetric adjacency matrix 562x562 with the industries in the row and columns. Then, to compute the proximity values between industries was adopted the formula of Hidalgo et al. (2007) which takes the lower conditional probability to have a larger share of employees in industry "i", given the larger share occurred in industry "j", as shown in the formula reported below.

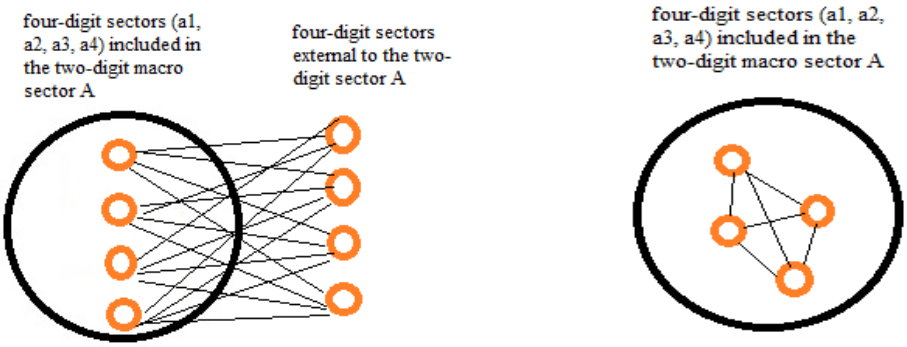
$$\phi_{ij} = min\left\{P(RCA_i|RCA_j), P(RCA_j|RCA_i)\right\}$$

Once obtained the 562x562 matrix of proximities between all the sectors, a measure of internal and external relatedness has been calculated for each of the 27 two-digit sectors taken into account to analyse the sectoral impact on new firm formation.

1) The first measure, the *external relatedness* is calculated among all the four-digit sectors (e.g. "a1", "a2", "a3", "a4") included in the two-digit sector "A" and all the other sectors at the four-digit level (see figure 4). It measures the synergies between the elements within a macro sectors and all the other external sectors, hypothesising that high values correspond to a high probability that two macro sectors could be a fertile milieu for cross-fertilisation.

2) The second measure, the *internal relatedness* has been computed *within* all the four-digit sectors (e.g. "a1", "a2", "a3", "a4") included in the two-digit sector "A". It measures the internal level of relatedness within a macro sector, supposing that high values point out the importance of productive factors or knowledge included in the same macro sector.

Figure 4. External Relatedness and Internal relatedness[18]



Source: author's elaboration.

Table 2. Summary statistics by sector

NACE REV 2. industry	Description	N° of new firms registered in 2012-2014	N° of incumbents 2012-2014 (average value)	Rel External 2011 (average values)	Rel internal 2011 (average values)
10	**Manufacture of food products**	4572	56902	0,4090	0,5219
13	**Manufacture of textiles**	1958	17173	0,2950	0,8114
14	**Manufacture of wearing apparel**	10937	48009	0,4512	0,7379
15	**Manufacture of leather and related products**	3997	21769	0,4185	0,4124
16	**Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials**	2471	38178	0,5344	0,6396
17	**Manufacture of paper and paper products**	270	4542	0,2361	0,4270
18	**Printing and reproduction of recorded media**	1584	19074	0,3296	0,4559
20	**Manufacture of chemicals and chemical products**	226	6077	0,1974	0,4694

[18] See the annexes for the formulas.

22	**Manufacture of rubber and plastic products**	877	12008	0,4278	0,6120
23	**Manufacture of other non-metallic mineral products**	1735	26361	0,2837	0,4189
24	**Manufacture of basic metals**	179	3767	0,1837	0,3889
25	**Manufacture of fabricated metal products, except machinery and equipment**	8474	101977	0,4974	0,6051
26	**Manufacture of computer, electronic and optical products**	662	10847	0,2072	0,4516
27	**Manufacture of electrical equipment**	946	13298	0,2526	0,5992
28	**Manufacture of machinery and equipment n.e.c.**	1639	30416	0,3195	0,7426
29	**Manufacture of motor vehicles, trailers and semi-trailers**	272	3369	0,2949	0,3701
30	**Manufacture of other transport equipment**	446	6010	0,1669	0,2144
31	**Manufacture of furniture**	1836	23790	0,4574	0,8312
32	**Other manufacturing**	3834	40942	0,2488	0,4177
33	**Repair and installation of machinery and equipment**	6949	27156	0,4514	0,6239
62	**Computer programming, consultancy and related activities**	7922	39742	0,2657	0,4506
63	**Information service activities**	7709	40116	0,4143	0,3489
70	**Activities of head offices; management consultancy activities**	8903	48119	0,2177	0,3323
71	**Architectural and engineering activities; technical testing and analysis**	2365	22762	1,4580	0,6084
72	**Scientific research and development**	675	4071	0,2563	0,4235
73	**Advertising and market research**	6723	33682	0,1183	0,3062
74	**Other professional, scientific and technical activities**	13123	55817	0,6853	0,5379

Source: author's elaboration on MOVIMPRESE Database

Table 2 shows some descriptive statistics to frame the context. The firms taken into account, considering the birth and the incumbents, represent the 15% in Italy in the period 2012-2014, in particular, the Manufacture of wearing apparel (NACE code 14) and Other professional and scientific activities sectors (NACE code 74) account for the 4% of the total birth.

For what concerns the level of relatedness, Architectural and engineering activities (NACE code 71), Other professional and scientific activities (NACE code 74) and Manufacture of wood (NACE code 16) have the biggest values of the external one, while Manufacture of furniture (NACE code 31), Manufacture of textiles (NACE code 13), Manufacture of machinery and equipment and Manufacture of wearing apparel (NACE code 14) have the highest values of the internal one. These results can be interpreted in line with the characteristics of the specific sectors: more complementary with external elements the ones with a high level of external relatedness and more influenced by the historical role of industrial districts the one with high values of internal relatedness.

Some control variables have been added to the model (they are summarised in table 3).

First of all, a provincial measure of relatedness is added to control its effect on new firm formation. It is a concentration measure computed summing up the proximity values for each sector by province (Innocenti and Lazzeretti, 2019a). The purpose of this variable is to control for the general measure of relatedness that may have some impacts on the process of new firm formation in specific sectors.

Second, to evaluate the role of agglomeration economies in the process of new firm formation, following Colombelli and Quatraro, (2017), we control for the incumbent's density for each sector "i" included in the analysis in each province "j". Accordingly, this can be particularly relevant in Italy to explain the possible "district effect" in some sectors and source of knowledge inputs for new firms.

Third, a population density variable is added to control for urbanisation levels, which could influence new firm formation at a local level (Baptista and Mendonça, 2010).

Fourth, following other studies on new firm formation, the unemployment rate at time t is included, as a possible determinant of new firm formation as stated in the entrepreneurship debate (see Audretsch and Fritsch, 1994).

Fifth, we introduce the human capital, which considers the number of graduates over the working-age population, a variable that has been associated with high entrepreneurial performance (Huggins et al., 2017).

Sixth, to evaluate the innovativeness of the province, we employ also patent as a classic knowledge stock variable for each province, to proxy for the innovation capacity of a local territory (Bae and Koo, 2008). The index considers the number of patents per million of inhabitant in the time span 2006-2011, with the formula $E_{i,t} = e_{i,t} + (1 - \delta)E_{i,t-1}$, where $e_{i,t}$

is the flow of regional patent and δ is the rate of obsolescence of 10% every year (Quatraro, 2010).

Seventh, given the importance of accessing financial resources to start and conduct entrepreneurial activities, we include the capital decay rate of investment for each province at time t that can be considered a proxy for the health of the territorial financial system (Colombelli and Quatraro, 2018).

Table 3. summary table of the Control Variables

Variable	Source	Year
Relatedness general: provincial index of relatedness among all four-digit sectors	ISTAT	2011
Firm density: ratio between the n° of incumbents in the industry "i" in province "j" and the surface of the province	MOVIMPRESE and ISTAT	2011
Unemployment: rate of unemployment for each province	ISTAT	2011
Population density: n° of inhabitants per Km^2	ISTAT	2011
Human capital: ratio between n° of graduates over the working-age population	ISTAT	2011
Patent Stock: the number of patents per million of inhabitant from 2006 to 2011 using an obsolescence rate of 10% every year with the formula $E_{i,t} = e_{i,t} + (1-\delta)E_{i,t-1}$, where $e_{i,t}$ is the flow of regional patent and δ is the rate of obsolescence	EUROSTAT	2011
Capital decay rate: the ratio between non-performing loans flows and performing loans (excluding non-performing loans)	ISTAT	2011
Openness: the ratio between exports in the dynamic sectors and total exports	ISTAT	2011
Business Incubator: dummy variable for the presence of incubators in the province	InfoCamere	2011
Spatial variables: NUTS 1 macro region variables	ISTAT	

Source: author's elaboration

Eight, even evaluating local patterns of new firm formation, in the actual context, the global dynamics are fundamental and the level of territorial internationalisation is considered important to stimulate the process of new firm formation, especially of those firms, that for dynamics of resource and market seeking born already "global". Therefore, following

Colombelli and Quatraro (2018), we include also a control variable for the "openness" of the territories, the ration between exports in dynamic sectors and total exports.
Finally, two dummy variables are included: one for the presence of business incubators, as entities that have the aim to foster the process of start-up of new firms (Colombelli, 2016) and another to account possible spatial patterns of the province location, in terms of NUTS 1 macro-regions (see Bonaccorsi et al., 2013).

3.4.4. Econometric strategy

The nature of our dependent variable, the simple number of new firms, suggests employing an estimation strategy under the umbrella of the Poisson family. Given high variability of new firms across provinces and sectors, we conduct a likelihood ratio test of the null hypothesis that the overdispersion coefficient is zero and the results (reported in each model) indicate the appropriateness of the negative binomial regression, a generalisation of the Poisson model (Hilbe, 2011). The specification of the model is the following:

$$\text{Newfirm}_{ij\,2012\text{-}2014} = \exp(\alpha + \beta 1 \text{Rel}_{\text{external}\,ij_{2011}} + \beta 2 \text{Rel}_{\text{internal}\,ij_{2011}} + \gamma Z_{ij\,2011} + \varepsilon_{ij})$$

The negative binomial regression is computed with robust standard errors and the vector Z in the equation indicates all the control variables mentioned in the previous subsection[19].
The correlation matrix (see table 5) does not report particularly high correlation level (the maximum is -0.63 between patents stock and unemployment)[20]. To detect the presence of multicollinearity, a VIF test was performed for all the 27 models reporting values that range from 3.34 to 5.71 (10 is the threshold).

[19] Due to space constraints, summary statistics and correlation matrix on new firms and incumbents are omitted.

[20] Notwithstanding some sectors report very high correlation between firm density and population density. The recent literature on new firm formation insert both the variables (see Bonaccorsi et al., 2013; Colombelli and Quatraro, 2017; Colombelli and Quatraro, 2018) Due to space constraints we do not report the correlation matrix including these variables across sectors, but we perform the 27 models with and without the population density and our estimators do not change.

Table 4. descriptive statistics[21]

Variable	Obs	Mean	Std.Dev.	Min	Max
(1) Relatedness	105	132.754	7.499	98.976	144.061
(2) Unemployment	105	8.424	3.794	3.308	17.592
(3) Density	105	265.639	372.223	38.887	2591.288
(4) Human Capital	105	0.102	0.017	0.076	0.163
(5) Patentstock	105	201.119	192.993	7.787	1145.951
(6) Capitaldecay	105	2.786	1.417	.357	8.712
(7) Openness	105	28.382	19.924	3.513	84.181

Table 5. Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Relatedness	1.000									
(2) Unemployment	0.477	1.000								
(3) Density	-0.426	0.008	1.000							
(4) Human Capital	-0.541	-0.240	0.243	1.000						
(5) Patentstock	-0.559	-0.636	0.167	0.254	1.000					
(6) Capitaldecay	0.317	0.351	-0.136	-0.105	-0.299	1.000				
(7) Openness	-0.083	0.012	0.143	0.179	-0.031	-0.008	1.000			
(8) Business incubator	-0.512	-0.228	0.329	0.400	0.439	-0.182	0.046	1.000		
(9) Spatial dummy NW	-0.241	-0.353	0.178	-0.166	0.265	-0.327	0.010	0.042	1.000	
(10) Spatial dummy NE	-0.218	-0.452	-0.017	0.134	0.506	-0.144	-0.091	0.310	-0.288	1.000
(11) Spatial dummy CE	-0.069	-0.128	-0.117	0.321	-0.138	0.087	0.141	-0.099	-0.337	-0.310

As a robustness check the model has been launched also considering new firm formation over a time span larger (five years) and the results substantially do not change.

Moreover given the fact that some sectors report a presence of zero's in the count of new firm, we decide to test our indicators of relatedness using also a zero-inflated negative binomial regression (ZINB), which allows to separate the effects, modelling simultaneously two equations: a count data regression and a logit model for the zero's, which needs the specification of at least a variable to explain their presence (in our case we use the simple number of existent firms in each sector at a provincial level) (see Fritsch and Falck, 2007; Colombelli and Quatraro, 2017). Using the ZINB, the impact of our variable of interest (external and internal relatedness) remains largely unchanged (only sector 15 changes significantly)[22].

[21] In the table are reported only the descriptive statistics of the control variables who remain constant for all the 28 regressions, excluding thus firm density and new firms.

[22] To determine the choice of the model between negative binomial regression and ZINB, in case of excessive presence of zeros, the Vuong test was used and values included in the range -1,96, +1,96 indicated indifference

3.5. Results

Table 6 shows the "synthtised" results of the estimation of the model presented above (reported with all the details in tables 7 and 8). This estimation has been repeated for each industry under consideration (27), searching for different impact of external and internal relatedness on new firm formation, adopting the lens of sectoral specificity (Bishop and Gripaios, 2010; Hartog et al., 2012).

Among the 27 two-digit sectors analysed, the variables representing the external and internal relatedness proved to be significant in 12 sectors. 11 of them are part of the manufacturing group and only one of the KIBS. Nine times the results showed a positive effect of external relatedness, while three times a negative one of internal relatedness and only one time a positive effect of internal relatedness. This confirms the hypothesis that the relationship between external and internal relatedness and new firm formation follows a pattern of industry specificity.

Commenting the results across industries, it is interesting to note that the effect of external relatedness is diffused among different typologies of manufacturing sectors, some more traditional and with artisanal features (as the 14, 18, 31, 32, 33), others with a larger scale of production (28 and 29) and others with a more science-based character (22). The same occurs with the effect of internal relatedness that, beyond the positive one in the textile industry, is registered with a negative sign in sectors more scale intensive (as 24) and more specialised as (27 and 32). Surprisingly almost the totality of the effects is in the manufacturing sector, with only the sector "activities of head offices, management consultancy activities" (70) with a positive impact by the external relatedness, an indicator that was expected to play a major role for KIBS.

Analysing the control variables, it is interesting to observe that the measure of general relatedness (between all four-digit sectors) of each province proved to be significant in 21 out of 27 sectors and always showing a negative impact on the process of new firm formation across sectors. This supports the idea that to conduct analyses across sectors, what matters is not the relatedness between all sectors, but the sector-specific measures of relatedness (Bishop and

between the two (Hilbe, 2011). In our case sectors 10, 20, 29, 30 register a value for the Vuong test outside the range indicated. However, the ZINB for these sectors confirms the same findings of the Negative Binomial Regression. Moreover, Vuong test, even if commonly applied in many papers, has been shown as inadequate because it "*assumes that the distribution of the log-likelihood ratios of zero-inflated models versus their non-zero-inflated counterparts is normal"* (Wilson, 2015, p.1).

Gripaois, 2010). The variable firm density is significant in less than half of the observed models, suggesting carefulness in the assessment of the effect of incumbents and the linked theory of knowledge spillovers (partially in line with the results of Colombelli, 2016; Colombelli and Quatraro, 2017; Colombelli and Quatraro, 2018). The variable that controls for population density should expect to be important as a source of competitiveness, but it performs very poorly in our model and only in few sectors, suggesting that the urbanisation dynamics do not play a crucial role in the firm formation when specific sectors are analysed. The variable unemployment has a negative effect in only two sectors, underlining its scarce burden in the sectoral patterns of new firm formation.

The control variables that aim to verify the impact of innovation in the process of new firm formation across sectors (as the stock of patents, the presence of business incubators and human capital) play a role in very few sectors, especially in the ones with high content of technical and scientific knowledge (e.g. stock of patents and presence of business incubators in the "manufacture of chemicals and chemical products" and "manufacture of computer, electronic and optical products" and human capital in "scientific research and development").

Finally, the variables Openness (on the percentage of exports by dynamic sectors) and capital decay (that proxies the goodness of the financial system) do not play any role at the provincial level across sectors.

Table 6. The results of the two main variables of interests for each industry[23]

NACE REV 2. industry	Description	External relatedness	Internal relatedness
10	Manufacture of food products		
13	Manufacture of textiles		**+****
14	Manufacture of wearing apparel	**+*****	
15	Manufacture of leather and related products		
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials		
17	Manufacture of paper and paper products		
18	Printing and reproduction of recorded media	**+*****	

[23] In this table are shown only the signs and the significance level of all the sectors (where *** p<0.01, ** p<0.05, * p<0.1), remembering that each industry has a different value of the external and internal relatedness.

20	Manufacture of chemicals and chemical products		
22	Manufacture of rubber and plastic products	**+*****	
23	Manufacture of other non-metallic mineral products		
24	Manufacture of basic metals		-*
25	Manufacture of fabricated metal products, except machinery and equipment		
26	Manufacture of computer, electronic and optical products		
27	Manufacture of electrical equipment		-*
28	Manufacture of machinery and equipment n.e.c.	**+****	
29	Manufacture of motor vehicles, trailers and semi-trailers	**+****	
30	Manufacture of other transport equipment		
31	Manufacture of furniture	**+****	
32	Other manufacturing	+*	-*
33	Repair and installation of machinery and equipment	**+***	
62	Computer programming, consultancy and related activities		
63	Information service activities		
70	Activities of head offices; management consultancy activities	**+****	
71	Architectural and engineering activities; technical testing and analysis		
72	Scientific research and development		
73	Advertising and market research		
74	Other professional, scientific and technical activities		

Source: author's elaboration

Table 7. Regression results for the manufacturing sectors

	(1) 10	(2) 13	(3) 14	(4) 15	(5) 16	(6) 17	(7) 18	(8) 20	(9) 22	(10) 23
Relatedness External	1.262	1.338	**2.787*** **	0.811	0.904	1.122	**4.587*** **	-1.191	**3.157*** **	1.514
	(0.723)	(0.943)	(0.556)	(0.736)	(0.515)	(1.246)	(0.997)	(3.542)	(0.563)	(2.082)
Relatedness Internal	-2.513	**9.993** **	-0.540	3.187	-2.096	-0.150	8.049	-1.492	1.511	-2.134
	(2.222)	(3.824)	(1.632)	(5.886)	(7.131)	(0.964)	(6.475)	(2.169)	(1.068)	(1.570)
Related. general	-0.034**	-0.042*	-0.042*	-0.042	-0.034**	-0.030*	-0.036**	-0.044*	-0.045*	-0.030*
	(0.013)	(0.020)	(0.018)	(0.032)	(0.012)	(0.017)	(0.014)	(0.018)	(0.023)	(0.014)
Firm density	1.315*	0.077	-0.176	3.445	1.237	15.414**	2.431*	7.509***	1.528	6.670***
	(0.772)	(0.259)	(0.123)	(1.795)	(1.404)	(5.358)	(1.131)	(2.140)	(2.356)	(1.359)
Unemployment	0.027	-0.042	-0.037	-0.018	-0.008	-0.003	0.022	-0.042	-0.017	-0.013
	(0.029)	(0.058)	(0.049)	(0.083)	(0.032)	(0.068)	(0.044)	(0.062)	(0.063)	(0.050)
Density	-0.000	0.001*	0.001**	0.000	-0.000	-0.001*	-0.000	-0.001*	0.000	-0.002***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
Human Capital	5.591	-0.757	8.796	7.779	5.215	-2.243	2.436	-13.616*	0.295	5.556
	(3.689)	(6.909)	(6.025)	(8.978)	(4.217)	(7.007)	(5.926)	(7.563)	(5.818)	(5.533)
Patentstock	0.001	0.001	0.001	0.002	0.000	0.001	0.000	0.002*	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Capitaldecay	-0.022	-0.027	0.048	0.199	0.009	0.116	-0.036	0.042	0.045	-0.013
	(0.045)	(0.052)	(0.071)	(0.181)	(0.047)	(0.071)	(0.061)	(0.095)	(0.081)	(0.043)
Openness	0.006	-0.003	0.002	-0.002	0.001	-0.004	0.004	0.006	0.003	0.003
	(0.003)	(0.005)	(0.005)	(0.008)	(0.003)	(0.006)	(0.003)	(0.006)	(0.005)	(0.004)
Business incubator	-0.034	0.038	0.371	-0.134	0.228	0.656**	0.135	0.426*	0.472*	0.224
	(0.176)	(0.233)	(0.228)	(0.248)	(0.169)	(0.238)	(0.146)	(0.233)	(0.254)	(0.214)
Cons	8.272***	0.022	7.690*	4.815	8.140	4.005	1.948	8.599*	5.220	6.797***
	(2.318)	(4.758)	(3.100)	(5.458)	(5.365)	(2.872)	(2.979)	(3.353)	(3.666)	(2.402)
lnalpha	-1.246***	-0.644***	-0.575***	0.431*	-1.382***	-0.815*	-1.426***	-1.478***	-0.659***	-0.932***
	(0.153)	(0.143)	(0.153)	(0.208)	(0.153)	(0.345)	(0.193)	(0.431)	(0.168)	(0.148)
NUTS 1 dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Obs.	105	105	105	105	105	105	105	105	105	105
Log likelihood	-458.171	-359.949	-514.748	-372.512	-399.297	-194.809	-347.148	-177.276	-288.568	-373.471
McFadden's R2	0.0733	0.126	0.117	0.113	0.050	0.121	0.104	0.142	0.129	0.062
Vuong test (z)	-2.62	-0.37	0.06	1.60	-0.12	1.49	1.36	4.50	1.04	-0.00
LR test on overdispersion	943.1 ***	619.4 ***	3734.6***	2637.9***	454.4 ***	31.6***	185.9***	7.7***	280.2***	421.7 ***
Mean VIF	3.72	3.06	2.99	4.13	3.55	4.20	4.51	3.62	3.39	3.84

Standard errors are in parenthesis *** p<0.01, ** p<0.05, * p<0.1

Table 7. Continued

	(11) 24	(12) 25	(13) 26	(14) 27	(15) 28	(16) 29	(17) 30	(18) 31	(19) 32	(20) 33
Relatedness external	4.762	0.936	-1.024	1.333	**3.362*** **	**1.437** **	-0.653	**0.872** **	**0.531***	**1.477***
	(2.662)	(0.760)	(0.828)	(1.522)	(0.911)	(0.458)	(1.899)	(0.276)	(0.263)	(0.648)
Relatedness Internal	**-6.846***	-0.899	2.051	**-5.142***	0.876	1.106	3.505	-4.170	**-5.626***	1.233
	(3.242)	(1.039)	(1.807)	(2.301)	(1.283)	(1.824)	(2.569)	(6.078)	(2.481)	(1.885)
Related.gen	-0.044*	-0.036**	-0.026	-0.040*	-0.040*	-0.016	-0.011	-0.034	-0.039**	-0.043**
	(0.019)	(0.013)	(0.014)	(0.016)	(0.017)	(0.017)	(0.019)	(0.023)	(0.014)	(0.014)
Firm density	10.495	0.502	2.574**	2.838*	1.092*	20.531	11.525***	0.479	1.917*	1.649
	(6.352)	(0.597)	(0.962)	(1.345)	(0.534)	(11.551)	(2.244)	(0.477)	(1.049)	(2.045)
Unemployment	0.045	-0.005	0.009	-0.089*	-0.018	-0.183*	-0.041	-0.048	-0.010	-0.012
	(0.059)	(0.038)	(0.059)	(0.051)	(0.049)	(0.084)	(0.070)	(0.057)	(0.044)	(0.041)
Density	-0.000	-0.000	-0.000	-0.000	-0.000	0.000	-0.001*	0.000	-0.001	0.000
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
Human Capital	1.138	2.534	-0.448	-0.510	-2.586	-6.779	11.982	3.229	4.476	0.109
	(8.298)	(4.259)	(5.474)	(5.844)	(4.392)	(7.193)	(6.695)	(5.663)	(4.496)	(4.595)
Patentstock	0.001	0.001	0.002**	0.001	0.001	0.002*	0.002	0.000	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Capitaldecay	0.094	0.021	-0.091	0.094	0.056	0.044	-0.016	-0.056	-0.009	0.001
	(0.061)	(0.054)	(0.071)	(0.078)	(0.063)	(0.088)	(0.075)	(0.054)	(0.044)	(0.055)
Openness	-0.002	0.003	-0.002	-0.000	0.004	0.008	-0.001	-0.002	0.002	0.001
	(0.006)	(0.003)	(0.005)	(0.004)	(0.004)	(0.006)	(0.006)	(0.004)	(0.004)	(0.004)
Business incubator	0.240	0.039	0.336*	0.285	0.411	0.146	0.382	0.164	0.238	0.134
	(0.220)	(0.154)	(0.186)	(0.203)	(0.234)	(0.241)	(0.270)	(0.208)	(0.179)	(0.149)
Cons	6.977*	8.416***	3.664	10.335***	5.880*	3.957	0.756	10.401*	10.146***	8.151***
	(3.466)	(2.046)	(2.530)	(3.000)	(2.592)	(3.025)	(2.900)	(5.585)	(2.294)	(2.449)
lnalpha	-1.188***	-1.154***	-1.002***	-0.705***	-1.092***	-0.896*	-0.519*	-0.662***	-0.986***	-1.076***
	(0.356)	(0.135)	(0.188)	(0.177)	(0.161)	(0.380)	(0.217)	(0.144)	(0.160)	(0.136)
NUTS 1 dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Obs.	105	105	105	105	105	105	105	105	105	105
Log likelihood	-162.209	-421.81	-260.868	-297.872	-338.556	-181.201	-237.242	-370.143	-436.119	-503.061
McFadden's R2	0.133	0.074	0.146	0.123	0.145	0.171	0.108	0.093	0.098	0.071
Vuong test (z)	1.43	0.07	1.38	1.09	0.93	2.56	2.35	-0.00	-0.21	-0.10
LR test on overdispersion	15.71***	877.95***	99.55***	220.34***	325.18 ***	22.01 ***	107.74***	622.27 ***	880.05***	1898.28 ***
Mean VIF	3.47	4.06	3.47	3.44	3.53	3.23	3.02	3.07	5.72	4.74

Standard errors are in parenthesis *** p<0.01, ** p<0.05, * p<0.1

Table 8. Regression results for the KIBS sectors

	(22) 62	(23) 63	(24) 70	(25) 71	(26) 72	(27) 73	(28) 74
Relatedness external	1.304	0.369	**6.347****	-0.469	0.182	4.835	-0.253
	(1.159)	(0.516)	(2.380)	(0.347)	(2.756)	(4.505)	(0.969)
Relatedness Internal	-1.082	19.906	-12.431	-2.968	5.143	-8.977	4.296
	(7.871)	(28.762)	(18.580)	(6.633)	(14.122)	(10.853)	(6.392)
Related.gen	-0.045***	-0.043**	-0.043**	-0.015	-0.054**	-0.057***	-0.048**
	(0.014)	(0.020)	(0.015)	(0.013)	(0.018)	(0.017)	(0.016)
Firm density	-0.205	0.891	-0.358	1.879***	-9.995	0.159	0.405
	(0.554)	(0.550)	(0.281)	(0.561)	(5.188)	(0.713)	(0.389)
Unemployment	-0.028	0.025	-0.038	0.011	-0.152*	-0.018	-0.036
	(0.036)	(0.042)	(0.042)	(0.032)	(0.065)	(0.052)	(0.042)
Density	0.001	0.000	0.001**	-0.001*	0.001*	0.000	0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Human Capital	4.319	4.588	-3.656	7.679	23.822**	0.931	1.965
	(5.444)	(4.744)	(5.048)	(4.716)	(7.292)	(6.177)	(4.661)
Patentstock	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Capitaldecay	-0.015	-0.008	-0.012	0.027	0.059	-0.048	-0.003
	(0.052)	(0.059)	(0.051)	(0.038)	(0.060)	(0.054)	(0.043)
Openness	0.002	0.002	0.005	0.005	0.002	0.003	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.004)	(0.003)
Business incubator	0.133	0.171	0.074	0.281*	0.275	-0.016	0.144
	(0.158)	(0.174)	(0.160)	(0.155)	(0.264)	(0.172)	(0.174)
Cons	9.831***	2.325	13.055*	6.362	5.726	13.612**	8.793*
	(3.657)	(8.081)	(6.410)	(4.176)	(6.901)	(4.156)	(4.225)
lnalpha	-1.084***	-0.928***	-1.100***	-1.492***	-0.753***	-0.714***	-1.084***
	(0.145)	(0.133)	(0.137)	(0.195)	(0.194)	(0.176)	(0.141)
NUTS 1 dummies	yes	yes	yes	yes	yes	yes	yes
Obs.	105	105	105	105	105	105	105
Log likelihood	-499.04	-514.551	-495.528	-383.274	-265.884	-490.890	-559.6641
McFadden's R2	0.108	0.073	0.132	0.100	0.133	0.094	0.083
Vuong test (z)	-1.03	-0.00	-0.02	-0.50	1.08	0.54	-0.60
LR test on overdispersion	2091.79***	2416.93***	1999.29 ***	321.92***	136.41***	2827.51***	3855.93 ***
Mean VIF	4.39	4.22	3.68	4.10	3.45	3.62	4.30

3.6. Discussion

The economic literature finds in the debate between specialisation and diversification a very useful starting point for discussing the role of agglomeration externalities in the promotion of economic growth. An emerging stream is debating how the knowledge composition influences the capacity of territories to give birth to new firms.

This paper contributes to this issue, analysing the sectoral specificity of relatedness. In light of the findings of the investigation, it is interesting trying to interpret the results of external and internal relatedness across sectors as possible explanations on the new entrepreneurship dynamics in the Italian context.

The sectors that benefit from a positive impact of external relatedness rely on a high degree of complementarity with other sectors in terms of sharing markets opportunities and/or production inputs and/or supplier/clients' relationships, underlining the importance of the proximity concept to understand the dynamics of new firm formation. Notwithstanding, from this type of modelling, we do not know with which specific sectors they need to interact to gain a benefit and further studies are necessary to deeply inquire the issue.

For what concerns internal relatedness, only a sector is positively influenced. In this case relatedness could be intended as an internal cluster of competences and resources and this relationship could be motivated by the positive effect of agglomeration economies in the process of new firm formation, considering also that the sector under consideration is the textile, within which the district effect seems still to play a relevant role in the dynamics of birth and survival of firms at the Italian level, at least for the medium-sized enterprises (Belso-Martínez et al., 2019).

For what concerns the negative effect of internal relatedness, the explanation could be the opposite: in this case, excessive specialisation could lead to "lock-in" situations that hamper and do not stimulate the process of new firm formation (Molina-Morales et al., 2014; Brekke, 2015). This high specialisation of the area could lead to high competition and eventually to entry barriers.

3.7. Conclusion and future avenues

The paper suggests that beyond possible interpretation of our estimators of external and internal relatedness, the results follows Bishop and Gripaios (2010), who analyse the role of relatedness on employment growth across sectors, finding great heterogeneity and posing the debate on the possible oversimplification brought by the simple distinction in manufacturing and services for the building of fitted policies. In a nutshell, the main contribution pointed out by this paper is that sectorial heterogeneity matter in the relationship between relatedness and new firm formation, in line with Colombelli et al. (2019, p.16) who point out how: "e*ntrepreneurship dynamics are sector specific, as far as the effect of local knowledge spillovers*".

This issue is particularly relevant also for policymakers, even if the concept of sector is not directly sustained in Smart Specialisation guidelines, which instead points out the need to adopt a thought transversal to sectors (McCann and Ortega-Argilés, 2017), concentrating for instance on the *Key Enabling Technologies* (EC, 2009; EC, 2012). However, the microdata per activities are mostly available for industrial sectors, making more complex their conversion into technologies. This calls for further efforts in the development of a taxonomy of economic activities, able to decompose macro-sectors and recombine them in different classifications and to overcome the simplistic duality low-high technology. A possible direction should be to use relatedness as a criterion to classify sectors, according to their level of proximity, the specific relatedness between sectors belonging to different NACE branches, purposely matched, can be measured in its cross-effect on new firm formation. Apart from the possible concerns with the concept of sector, one of the points raised by advocated of S3 is that economic development of regions should be based on (but not limited to) the existent knowledge structure trying to discover what is called the "*adjacent possible"* (Foray, 2015), avoiding policy targeted only on high-tech sectors (Brown et al., 2017). This policy approach is consistent with the idea that to understand the interplay between the birth of new firms and the proximities levels within industries and/or technologies across individual sectors (of course avoiding a too broad level of granularity) can be one of the mechanisms of the discovery process (Foray and Goneaga, 2013, Boschma and Gianelle, 2014). Particularly, the interpretative frameworks posed by S3 is to adopt a systemic view of economic development, oriented to the general challenges of Europe (e.g. reducing unemployment, increasing sustainability, eradicating poverty and increasing R&D expenses), but at the same time exploiting the potentialities that each region and territory

can have also in terms of "path creation". Setting up a business is the first step, but many stages are needed to transform new entrepreneurship into economic growth.

In addition, the relationship between new firm formation and relatedness can give rise to different explanations of "typologies" of structural transformation. If the birth of new firms is fostered by a thickening of competences mainly internal to one sector (the case of internal relatedness), this could signify an upgrading in terms of new business models, or the identified need for complementary or higher quality businesses. If the birth of new firms in a certain sector is boosted by the presence of some related but external sectors (the case of external relatedness), this could mean that some territories are more "sensitive" to re-employ their skills in different sectors, towards a diversification direction.

However, facing the topic of entrepreneurship with the right level of heterogeneity is not enough: the dynamics of entrepreneurial process and its relationship with knowledge and innovation is a complex issue.

It goes without saying that many variables come into play, as the possible mediating role of universities and research centres, the combination and interrelation of knowledge between and within individual sectors and the means of diffusion and transfer of knowledge as firm diversification, spinoffs, labour mobility and social networking within regional entrepreneurial ecosystems (Bochma and Frenken, 2009). A future agenda should address specific issues as a new definition of entrepreneurs, the identification of the business environment, the institutional barriers and a shared mission of long-term purposes among various spheres of the society (Henning and McKelvey, 2018).

In conclusion, some future avenues are synthesised to complete and deep the general framework.

- The absorptive capacity of the system: entrepreneurship means also an entrepreneurial mindset of the existent organisations (firms and institutions) and the action of agents to explain the micro-foundations in the recombinant process of knowledge. Policy measures need a fertile milieu able to absorb the resources made available.
- The nature of knowledge and the ways of transfer: relatedness has been inquired mainly as a dyadic process, but can occur at multiple and parallel levels, including several factors (geographical, social/relational, institutional, technological, managerial, etc..). In-depth studies (also qualitative) are needed to further clarify this issue.

- The new function of entrepreneurs as coordinators of multidisciplinary competences that evolve on the techno-economic frontier, on which products and services have become multi-technology, multi-domains and multi-functions.
- Regional branching: one of the main mechanisms to explain the S3 logic, is not only a local process, but it depends also on global sources of knowledge: could we insert in future analysis an *extended regional branching* concept? How the actors can contribute to integrate different sources of knowledge posed at different scales?

4. The Entrepreneurial Discovery Process between relatedness and entrepreneurial agency. A focus on the EDP of Tuscany

4.1. Introduction

Smart Specialisation Strategy (henceforth S3) has been defined as the capacity of an economic system to discover new paths of (structural) development on the basis of the existent local endowments of tangible and intangible resources (Foray, 2015). Within the framework of S3, the Entrepreneurial Discovery Process (henceforth EDP) has been promoted as the main tool of application and element of distinctiveness that discriminates S3 from the other industrial strategy (Borrás and Jordana, 2016). The idea of discovery should be intended as a concrete attempt made by the actors active on territories, namely "*companies, higher education institutions, public research institutes, researchers and independent innovators*" (Del Castillo Hermosa et al., 2015, p.9) to collaborate with an "explorative mindset" towards the innovation process, under the guidance of local policymakers. The idea of the EDP is thus to exploit the hidden and fragmented entrepreneurial knowledge, owned by firm entrepreneurs, research leaders, inventors and innovators in a combinatorial way, following a logic of pace and tempo, where some activities can require more time to be disclosed and different practices can be adopted (Foray, 2015). The final aim of EDP is to identify those priorities able to promote structural change relevant for the path development of the region, producing relevant information for decision-makers and empowering the more important local actors, facilitating the participatory process (OECD, 2013; Del Castillo Hermosa et al., 2015).

The structural change has been studied by the literature on path dependence and path creation (David, 2005; Martin and Sunley, 2006; Simmie, 2012), but a more nuanced version closely linked to the idea of S3 comes from the studies by scholars of Evolutionary Economic Geography (Boschma, 2017; Balland et al., 2018). In particular, the concept of relatedness seems very useful to describe the design phase of the EDP, allowing to map possible areas of future development in which a region can invest to take advantage of its existent strengths, identifying possible connections between industries and knowledge domains (Foray, 2015). As an example, if a region "A" presents strong capabilities in textile and mechanical sectors, a possible direction could be to invest in a third transversal sector such as the ICT to digitalise machines used in the cutting phase of the leather production. This could allow to trace all the data and integrate the machine to machine communication, reducing errors and making more efficient the process.

The application of relatedness methodologies allows to focus on the areas that represent already excellences or that can constitute emerging opportunities, facilitating the task of policymakers in the initial phase of EDP, looking for the eventual bottlenecks and conduits to organise the sequential phases of EDP.

However, relatedness between technologies, products or skills is a condition necessary but not sufficient to explain the implementation of EDP. Some scholars have recently proposed to integrate the concept of relatedness with a perspective more focused on agency (Boschma et al., 2017). The introduction of a recursive relation between the connection's structure and the entrepreneurial agency of actors involved in the EDP could be relevant to advance the theoretical interpretation of the concept. This could allow to overcome the principle that co-location automatically implies exchange of knowledge (Morgan, 2016), integrating in the model a pro-active role of entrepreneurial agents (meant in the broad understanding of EDP) as "knowledgeable filters" of the proximity levels detected by relatedness techniques (Binz et al., 2016). Moreover, multiple and parallel levels of relatedness can occur, pointing out how actors can be connected on one side by technological proximity, but other institutional barriers can impede the effective development of the potential relationship (Bugge and Øiestad, 2015).

The aim of the chapter is to analyse the EDP, considering the concept of relatedness as a mapping tool to orient the initial design phased of the EDP (as scouting and foresight) and from the point of view of institutional agents. These actors, involved in the process, are able to "rationalise" the demand for innovation expressed by the world of business and to flexibly adapt it to technologies and sectors that show proximities between them with an actor-system view (Isaksen et al., 2018). The chapter uses a mixed methodology, applying this interpretative framework to the case of Tuscany Region.

Firstly, it is developed a quantitative mapping of the connections between industrial sectors of Tuscany, using the Product Space techniques of Hidalgo et al. (2007) applied to employees (following Innocenti and Lazzeretti, 2019a). Then, semi-structured interviews are administered to the main institutional actors involved in the EDP, the Technological Districts (represented by their managers), with the purpose to inquire their role in the development of EDP, particularly focusing on how they set up their planning strategies and through which mechanisms integrate knowledge and combine firms and R&D peculiarities.

The chapter is organised as follows. The second section discusses in detail the framework of analysis (relatedness-entrepreneurial agency) proposed to refine the concept of EDP. The third section frames the aim and states the research questions. The fourth section describes the methodology adopted to

conduct the research. The fifth section presents the results for the case of Tuscany. In the sixth section is reported the discussion of the findings. The last section presents the implications for the EDP and for to the regional innovation policy literature.

4.2. An interpretative framework to analyse the EDP the complex context shaped by relatedness and entrepreneurial agency

4.2.1. Why relatedness is not enough to explain the EDP?

The EDP encompasses the idea that to promote structural changes at a regional level, the creation of new economic activities should consider what is the knowledge and the relative "meta-infrastructural endowments" available at a local level and what are the networks on which this knowledge is distributed and channelled (Foray, 2015).

The production of *knowledge per se* does not constitute the object of EDP, but the integration and cross-fertilisation of knowledge bases that can differ in a range of degree. The concept of knowledge base was introduced by Asheim and Gerlter (2005) and inspired by the work of Laestadius (1998). It was associated with concepts referred to geography and innovation such as regional innovation system, knowledge networks, geographic concentration of activities and the theory of path dependency (Boschma, 2018). The concept of knowledge base has allowed to enlarge the set of policies measure relative to innovation from the general R&D and high-tech policies, towards a more complex framework where the heuristic strategy is based on a possible number of combinations, given the local endowments and the capacity to expand them through networks, internal and external to the context (Manniche, 2012; Isaksen and Nilsson, 2013; Tödtling and Trippl, 2018).The specific combination of different types of knowledge constitutes, beyond its simple accumulation, one of the possible reasons put forward by scholars and policymakers in the attempt to explain the different evolution of path creation in regions. These theoretical foundations seed at the basis of the so-called literature on "relatedness". Relatedness is intended as the capacity of diversification among technologies, production processes, activities, or more broadly knowledge bases, with a high degree of connection respect to the ones already established on the regional/local context (Boschma, 2017). Relatedness has been studied by organisation studies, trying to understand the similarity of capabilities, observing the incidence of co-occurrence between products at the plant level (Teece et al., 1994; Teece et al., 1997). The concept has been moved forward by the approach proposed by

evolutionary economic geography, which has shifted the unit of analysis to the territory (city, region, state), analysing the co-occurrence of products within the same plant firm, region or country (Hidalgo et al., 2007; Neffke et al., 2011), co-occurrence of technological classes within the same patent (Breschi et al., 2003; Kogler et al., 2013; Rigby, 2015), citation flows, input-output linkages, inter-industry labour flows (Neffke and Henning, 2013). The abovementioned studies represent only a part of the literature on relatedness that is noteworthy increasing in the last years, allowing to pass from a conception of industrial base as substantial stable (e.g. Frenken et al., 2007; Boschma and Iammarino, 2009), to new conception that consider the dynamic and evolutionary character of it, from the paper on the *Product Space* by Hidalgo et al. (2007) to more recent paper, such as the one by Balland et al. (2018). This is especially valuable because it embodies the interconnectedness character of global production, where the evolution of an input expands the possibility frontier of other production output, apparently distant (Hidalgo, 2018).

The findings of the studies on relatedness, mainly conducted in Europe and the US, have brought important implications in terms of the pace of inventions, the coherence of technologies in the technological trajectories with the already existent ones and the probability that new sectors or technologies prosper in cities or regions. (Kogler and Whittle, 2018).

The relatedness literature, which specifically looks at the combinatorial aspects of knowledge, has been adopted even by S3 proponents. Foray (2015) describes explicitly how the concept can help in the process of structural transformation, which he identifies in different kinds, such as transition, diversification and modernisation. It appears very clearly how the relatedness can constitute a solid theoretical and methodological basis that EDP would need in its establishment, facilitating the initial narrowing phase of the areas to be "discovered". The pattern of diversification is expected to evolve according to the structure evidenced by various measures of relatedness (Xiao et al., 2018), which could identify the eventual bottlenecks in a logic of development brick by brick (Boschma and Gianelle, 2014; Balland, 2016).

Notwithstanding, the measures of relatedness computed up to now, have mainly been realised considering products and industries and not the transversal technological domains[24] that are identified in the S3 logic (Iacobucci and Guzzini, 2016). The reflection could be set on the research of "different or new metrics" able to improve the representation of S3, but this effort, even if recently taken by

[24] This is a problem of how the data are gathered. There has an attempt at European level to translate economic sectors into S3 priorities (see http://s3platform.jrc.ec.europa.eu/map), but the technological domains, as suggested by the principles of S3, cannot be exactly identified by specific economic sectors. Moreover, the nature of data is often limiting the possibilities of researchers: if the patent rate in less-technological developed regions is low, the patent data could not provide a realistic depict of the regional connections within the ecosystem

some studies (see for instance the use of "technology diffusion approach" to measure regional branching with patent by Montresor and Quatraro, 2017) is not a simple issue to treat.

Beyond this point, some critical points can be raised concerning the relation between relatedness and EDP. Firstly, relatedness can be intended not only in terms of technology, skills, sectors but also in managerial models, types of organisations, learning dimensions and entrepreneurial culture (Breschi et al. 2003; Bugge and Øiestad, 2015). Accordingly, Hidalgo et al. (2018, p.454) purposely embrace this criticism, defining relatedness as: "*the variety of mechanisms by which economies and organisations learn*". Therefore, it is not only a matter to understand what combinations of knowledge is to be supported, but also to study the relation between components of the system and the ability of the innovation landscape to absorb knowledge (Cohen and Levinthal, 1990; Boschma, 2018).

Secondly, the co-locations found trough relatedness techniques per se does not imply an automatic knowledge recombination process (Morgan, 2016; Carvalho and Vale, 2018; Kogler and Whittle, 2018). The same authors who measure and discuss the relatedness approach have recently opened a debate on the potential weaknesses of the concept, if blindly applicated to innovation policies and strategies, claiming for the inclusion of concepts such as institutions and agency (Boschma et al., 2017).The next paragraph presents the theoretical approach that could integrate the literature on relatedness, which per se cannot be considered exhaustive to approach the innovation policies, especially as the case of EDP, which presents several aspects that are still in a developmental phase.

4.2.2. The overlapping space of relatedness and entrepreneurial agency

When we discuss the EDP, the centre of the debate is to set a strategy to promote a process of economic development stimulated by different knowledge sources, combined and recombined into new path development rooted in discontinuous techno-economic trajectories. This idea moves forward the concept of *Open Innovation a là* Chesbrough (2003) and promotes a pattern based on a set of changeable combinatorial spaces that adapt to the specificity of places and problems to solve. In this context, the term learning economy well characterises the dynamicity of the innovation processes embedded in a systemic and overlapped perspective in which actors evolve and contribute to the exploration phase of economic development (Asheim and Coenen, 2005; Uyarra and Flanagan, 2010; Grillitsch et al., 2018).

Hausmann (2008) points out how the role of this "decentralised search" that is occurring in a rapidly evolving context, is more and more a matter of adopting an approach eager on complexity. Current innovation landscape is composed by a number of interacting dimensions, populated by different

actors that communicate through many conduits and languages (that sometimes work in parallel), integrating the sparsely diffused information (Hausmann, 2008). Hausmann (2008) provides the concept of *high bandwidths* as "meta channels" where "*problems are identified and addressed"*, adopting so a systemic approach that appears very useful to comprehend EDP in its decentralised and multiple forms:

"Instead of focusing on a low number of potential silver bullets, an effective development strategy should focus instead on the mechanisms that allow for a greater capacity to process information and ideas, i.e. to increase bandwidth. The alternatives are either to embrace complexity and deal with it or hide from it. Embracing it implies working not only at the level of the many individual policy actions that may be required but more importantly at the meta-level of the structures whereby problems are identified and addressed. This is what will ultimately allow societies to deal with the complexity they face" (Hausmann, 2008, p.31).

This interaction between actions taken at the individual level and "structures" is a topic that originates in sociology. A famous research by the sociologist Giddens (1979) introduced the structuration theory, which described the social reality as made by the inseparable duality between structure and agency, which co-evolve, mutually influencing each other. Accordingly, social phenomena occur in open systems that are causal (power of objects and structure) and interpretative (capacity of human agency to understand the meaning attached).

Recently even in the field of innovation policy and evolutionary economic geography the idea that agency matter is growing (Boschma et al., 2017). The deterministic models where agents are just considered "*automaton-like processors of objective information rather than interpreters intrinsically ambiguous symbolic inputs*" (Garud et al., 2007, p.961) are now critically approached. Until few years ago, the tendency in innovation studies was to "*focus rather more on the presence (or absence) of classes of actors and institutions than on their roles, relationships, and performance that is, on the characteristics that make the system a system"* (Uyarra and Flanagan, 2010: 683).

There is a growing literature in regional studies that recognise the role of agency to transform "chains of information" into knowledge, after a phase of interpretation, filtering and choice (Hautala, and Höyssä, 2017). The impact of agency in innovation systems is visible in the creation and maintenance of interdependent innovative networks based on science-driven (Science, Technology, Innovation) and user-driven (Doing, Using, Interacting) approach and beyond the scientific value on the market side, work mobility and social relationship (Isaksen and Nilsson, 2013; Martin and Moodysson, 2013; Grillitsch and Trippl, 2014).

These entrepreneurial agents are embedded in the structures that they contribute to create through a process of "*mindful deviation*", defined as the capacity of actors to adopt a detached perspective on what could be the most promising trajectories of development (Garud and Karnøe, 2001).
The modality that allows to influence the institutional environment is a sort of "bricolage approach", defined like this because it recalls the image of bricolage activity, explaining the path creation strategy as a co-shaping process composed by the multiple visions of actors embedded together in the same puzzle (Garud and Karnøe, 2001). This approach develops with a non-linear dynamic path along the coordinates of experimentation and exploration, is based on the interaction of agents, which results in different activities of learning and problem-solving, such as negotiations, market creation, establishment of rules (formal and informal) (Garud and Karnøe, 2001; Bathelt and Boggs, 2003 Boschma et al., 2017).
Considering the rationales of EDP, the importance of entrepreneurial agents is visible in the shaping of social networks that cross multiple structures, in the mobilisation of resources and in the strategic decisions (Grillitsch, 2017; Isaksen and Jakobsen, 2017). This requires the inclusion, in the schematic framework of EDP, of the entrepreneurial agency, intended as the capacity of actors to shape (and be shaped by) the structure, influencing the final outcome of the process (Garud and Karnøe, 2003; Garud et al., 2007, Simmie, 2012). In particular the practice of bricolage assumes particular relevance in the EDP logic: technological domains that emerge as somehow connected by a certain degree of relatedness can be "verified in their consistency" by the entrepreneurial agency that can include "specific contingencies" in the processes of discovery and assessment, conferring to the relatedness a role of "enabling platform" to unfold opportunities (or to exclude dead-end strategy) (Garud and Karnøe, 2007; Fabbri, 2016).

4.2.3 The role of institutional entrepreneurship in the EDP

The two previous subsections have introduced the motivations to include agency as a crucial part of the economic structural change, object of the EDP. However not all the actors own the same degree of agency: some can be more central in the network of relationships between firms, some can be the gatekeepers of scientific knowledge exchange, as the leading research centres, technologies agency or incubators, others can have important potentialities but be at the margin of the network or with no connections at all. The point is that agency is distributed heterogeneously between actors, even if dimension, type of organisation/managerial models, good reputation can influence their

position in the network, helping scholars and pundits to identify archetypes of actors (even if S3 guidelines prescribe to be agnostic in discovering promising connections).

In the recent literature on EDP and S3, scholars have pointed out as particularly relevant the role of the so-called institutional entrepreneurs. The literature on institutional entrepreneurship is rapidly growing in the last years, and even if the definition of who are the institutional entrepreneurs remains an open debate (Sotarauta and Pulkkinen, 2011).

Sotarauta and Pulkkinen (2011, p.100) define institutional entrepreneurs as follows:

"individuals, organizations, or groups of actors who not only introduce the needed change and/or innovation but also work to change the broader context so that the innovation has a widespread appeal and impact"

The main idea is that these kinds of entrepreneurs actively participate in the changes that occur within the organisation or within the broader institutional context where they operate, screening a big quantity of information (Battilana et al., 2009; Sotarauta and Suvinen, 2018). Institutional entrepreneurs can acquire their role even *in fieri* without an initial plan and even without guarantee of success (Battilana et al., 2009).

The idea that "no technology exists in a vacuum" (Garud et al., 2002, p) reinforces the position of institutional entrepreneurs that are identified as strategic actors, who can act on different sides of the multiple structures of the regional networks: social relationships, governance perspective and sharing of technical/scientific knowledge (Garud and Karnøe, 2001; Garud et al., 2007; Hung and Whittington, 2011; Sotarauta and Pulkkinen, 2011).

The activity of institutional entrepreneurs is mainly definable according to the temporal constraints, the availability of resources and the smelling of opportunities. The temporal scheme is important because decisions are taken, considering the "*interplay of the habits, imagination, and judgement of actors"*, in relation to past, present and future (Dorado, 2005). The theme of resource is crucial across several dimensions: financial resources, social capital, establishment of rules and political engagement with the others (Battilana et al., 2009).

The smelling of opportunities is probably the most relevant requisite to own by institutional entrepreneurs. Institutional entrepreneurs should develop a vision of change, considering a diagnostic framing, scanning the situation (e.g. what are the weak points?) and a prognostic framing, engaging the other agents (e.g. if they prepare a plan considered superior to the previous needs to convince the other actors, trying to coordinate and align their interests and values with the other actors involved) (Maguire et al., 2004; Battilana et al., 2009).

Particularly relevant for the innovation systems and thus even for the EDP can be considered the intermediates as institutional entrepreneurs able to diffuse new ideas in the system and to find new applications for technologies that are not completely new per se, but in their combined application, outside their initial scope (Howell, 2006). Jain and George (2007), studying the case of technology transfer offices, classify the three distinct roles that intermediates can cover as institutional entrepreneurs: protectors, propagators and influencers. The activities of the intermediary bodies are various and go from: to facilitate the collaborations, providing information to the right actors about possible collaborators, to mediate between these parts between actors/organisations that are already engaged in a collaborative relationship, to support the search for funding (as sharing of information on public procurements (Howell, 2006; Watkins et al., 2015).

4.3. Aim of the work and Research Questions

Complementarities and similarities between actors are structured along multiple networks that are not only of dyadic nature, but can be articulated even in one-to-many, many-to-one, and many-to-many (Bessant and Rush, 1995; Howell, 2006). This means allowing a complex view of innovation channels, towards a multidimensionality framework (Hausmann, 2008; Bugge and Øiestad, 2015). Accordingly, Bugge and Øiestad, (2015, p.769) claim that:

"These objections support the view that there is a lack of nuances in the related variety concept in terms of distinguishing between different parallel dimensions of relatedness. This implies that different actors may be related in some regards but unrelated in others".

The aim of the chapter is thus to study EDP, using an interpretative framework composed of relatedness and entrepreneurial agency. The idea is to observe the process of discovery considering how the mechanisms of relatedness work at a micro level, if jointly analysed with the multiple networks of entrepreneurial agents. The first research question is:

RQ1) How relatedness works at different levels of analysis? And what "nuances" emerge at the micro-level?

To study the role of agency in comparison to the relatedness approach from an empirical point of view, the present work analyses the EDP of an Italian region, Tuscany, looking at what has been the

role of entrepreneurial agents in the development of the strategy. The choice of a case study is due to the fact that each region can structure the EDP in a different way, making more difficult to compare regions using only quantitative tools. The chapter concentrates on the role of institutional entrepreneurs, because this particular category can help to understand how the different type of relatedness work in practice: (i) agency in the system is not distributed homogeneously between actors, (ii) the institutional entrepreneurs often occupy central position in the knowledge networks (iii) this gatekeeping position can implies the development of greater ability to critically analyse the functioning of the systems (iv) institutional entrepreneurship have a broader vision of the specificity of the context (Emirbayer and Mische, 1998; Dorado, 2005; Garud et al., 2007; Garud et al., 2010; Rodríguez-Pose and Wilkie, 2015).

In this work, we consider a specific category of institutional entrepreneurs, the Technological Districts (TDs) of Tuscany, created by the Regional Government to integrate and "reorganise" the technological transfer system (including firms, research centres and universities) and therefore ascribable as institutional agents for territorial development[25]. TDs and other intermediate entities of technology transfer in Tuscany have been analysed concerning their skills and competences (and their evolution) and regarding to their performance in comparison to policy objectives (Russo et al., 2018; Russo et al., 2019).

The choice of TDs as institutional entrepreneurs is motivated by their strategic position "*at the nexus of scientific discovery and commercialization activity"* (Jain and George, 2007, p.538) and mostly for their deep involvement to set and implement the S3 with "*clear rules of engagement to conduct foresight and roadmapping exercise*" in the process of discovery, involving the key stakeholders, organising workshop relative to their topic of competence and addressing topics such as "*industrial clustering dynamics, human capital needs, technical/industrial problems and innovation/industrial networks*" (Fabbri, 2016, p.500). This leads to the second RQs:

[25] The role of intermediaries in Tuscany has important historical roots traced to 1960s. They were created as public-private organisations to provide services to the small firms of Tuscany, often specialising in the traditional sectors of Made in Italy typical of Industrial Districts (Russo et al., 2018). TD can be seen as the "successors" of Innovation Poles as intermediary entities, but with different aims. Innovation Poles had to provide services to the affiliated subjects of the poles, supporting companies and carrying out many qualified services with consequences in the short run. The latter have a broader aim to contribute to the development and coordination of territorial competitiveness with few but key projects managing partnership between companies, universities and research institutions related to a specific technology, with a focus on the long run (Russo et al., 2014).

RQ2) What are the mechanisms through which the institutional entrepreneurs identify the bottlenecks and the potentialities of the ecosystem, promoting knowledge exchange and influencing the final outcome of the EDP?

4.4. Research Design

4.4.1. Methodology and data collection

This chapter adopts a qualitative methodology arranged as an "embedded case study" (Yin, 2018). Case studies are rich contextualised examples that rely on multiple data sources, in particular, embedded case studies, a form of mixed-methodology, allows to use quantitative and qualitative data with a nested structure (Gehman et al., 2018; Yin, 2018). A complementary perspective permits to look at the phenomenon from different points of views, with a multisided (and often overlapped) comprehension of it (Greene et al., 1989), with the goal to inquire how relatedness concept works at the macro and micro levels considering also the actions of institutional entrepreneurs.

Initially, to evaluate and map the proximity levels between industrial sectors of Tuscany, it has been computed an "Industry Space" adapted on the methodological approach of Product Space[26] (Hidalgo et al., 2007) to employment (Innocenti and Lazzeretti, 2019a).

The procedure has been developed as follows. Employment data at 4-digit level (562 industries have been considered) divided by NUTS 3 (110 Italian provinces) have been harvested from ISTAT Census of 2011 and inserted in the matrix form according to the Balassa formula of Relative Comparative Advantage (RCA), computing the comparative advantage of each industry for each province. Each province with a value of "1" in the industry "i" has been considered with a comparative advantage respect to the other provinces in the number of employees of the same industry "i" (and vice-versa if the province displayed a "0"). The 110x562 (provinces by sectors) matrix has been then converted to a symmetric adjacency matrix 562x562 with the industries in the row and columns.

To compute the proximity values between industries has been adopted the formula of Hidalgo et al. (2007), which takes the lower conditional probability to have a larger share of employees in the industry "i", given the larger share occurred in industry "j", as shown in the formula reported below:

[26] The methodology of Hidalgo is available at this link.

$$\phi_{ij} = min\left\{P(RCA_i|RCA_j), P(RCA_j|RCA_i)\right\}$$

Once obtained the 562x562 matrix of proximity, the values have been multiplied by the adjacency matrix of the RCA of the 10 Tuscan provinces for 562 industries, realising the Industry Space of Tuscany. Once obtained the connection tree, it has been embraced a graphical representation focused on the manufacturing and Knowledge Intensive Business Sectors (KIBS), following He et al. (2015).

Then the qualitative part of the methodology has been conducted with semi-structured interviews directed to the coordinators and/or cluster managers of the Technological Districts of Tuscany. Firstly, this is due to the fact that each region decides its own EDP strategy. Therefore, the possibility to establish a direct contact with the people working at the TDs has permitted to analyse how "institutional entrepreneurs" shape the relatedness concept at a micro-level, contributing to the EDP development. Semi-structured interviews are insightful and leave room for personal opinions, thanks to the possibility to explore the explanations of actors, which, in this case, participate directly in the strategy building process (Creswell and Creswell, 2017).

During the interviews, 4 open-ended questions have been used to lead the conversation. The topic scheme covered these points:

- Role and strategic actions of the Technological District in the knowledge exchange process
- Relationships with entrepreneurs and the establishment of partnerships
- Start-ups as a mechanism to promote new knowledge conduits
- Relationship with universities and R&D centres

Given the potentiality of TDs to attribute specific meaning to the points raised, our research strategy has been to have a face to face interaction with TDs managers, visiting their head offices, located in different provinces of Tuscany (with the exception of two interviews that were administered with online modalities). The interviews were conducted between January and March 2019 and lasted from 55 minutes to 1 hour and 40 minutes and each of them was registered and then

fully transcribed[27]. After the contents were systematised and sixteen pages of notes have been produced.

To triangulate our data, we reviewed the strategic plans of the 8 Technological Districts to find further evidence and we employ a "member checking procedure" to validate the qualitative findings of the "*semi-polished product"* thanks to the experience of a key informant (Creswell and Creswell, 2017; Yin, 2018). This has been possible thanks to the support of Regional Government of Tuscany, Managing Authority of Operational Programme EFRD 2014-2020[28].

Moreover, this study has beneficiated of a four months visiting period of the author at the Managing Authority of Operational Programme EFRD 2014-2020 of Regional Government of Tuscany. This conceded a privileged point of direct observation of the everyday setting and routines (Yin, 2018) of S3, specifically for what concerns the monitoring actions, the relationship management of regional officers and a deep understanding of the EDP phases.

4.4.2. Data analysis

The analysis of data still represents an underdeveloped part of case studies (Yin, 2018). As suggested by the literature "*researchers must immerse themselves in the data"*, hence both quantitative and qualitative sides have been examined in order to understand possible patterns and to deal with the complexity of the topic (Reay and Jones, 2016). Notwithstanding there not exist "*fixed formulas or cookbook recipes to use as guides"*, except having a good "*analytic strategy*" (Yin, 2018). The procedure that we employ was partially deductive, so drawn by the comparison with the existent literature or relevant documents and partially inductive, so based on what agnostically emerges from the data. Especially the qualitative part has involved the author to read and re-read the interviews' results several times with an eye to the main propositions expressed by the literature. This mixed analytical method seems coherent with the topic of relatedness, which has received a lot of attention in the last decade (so it is important to match the results with the literature), but which still deserves many efforts to understand its micro aspects and the role of institutional entrepreneurs to shape it.

[27] With the exception of one interview which was conducted via e-mail and the final notes were provided by the Technological District's staff.

[28] Represented by Emanuele Fabbri, policy maker officer working in the Managing Authority of Operational Programme EFRD 2014-2020 of Regional Government of Tuscany.

4.5. The case of Tuscany

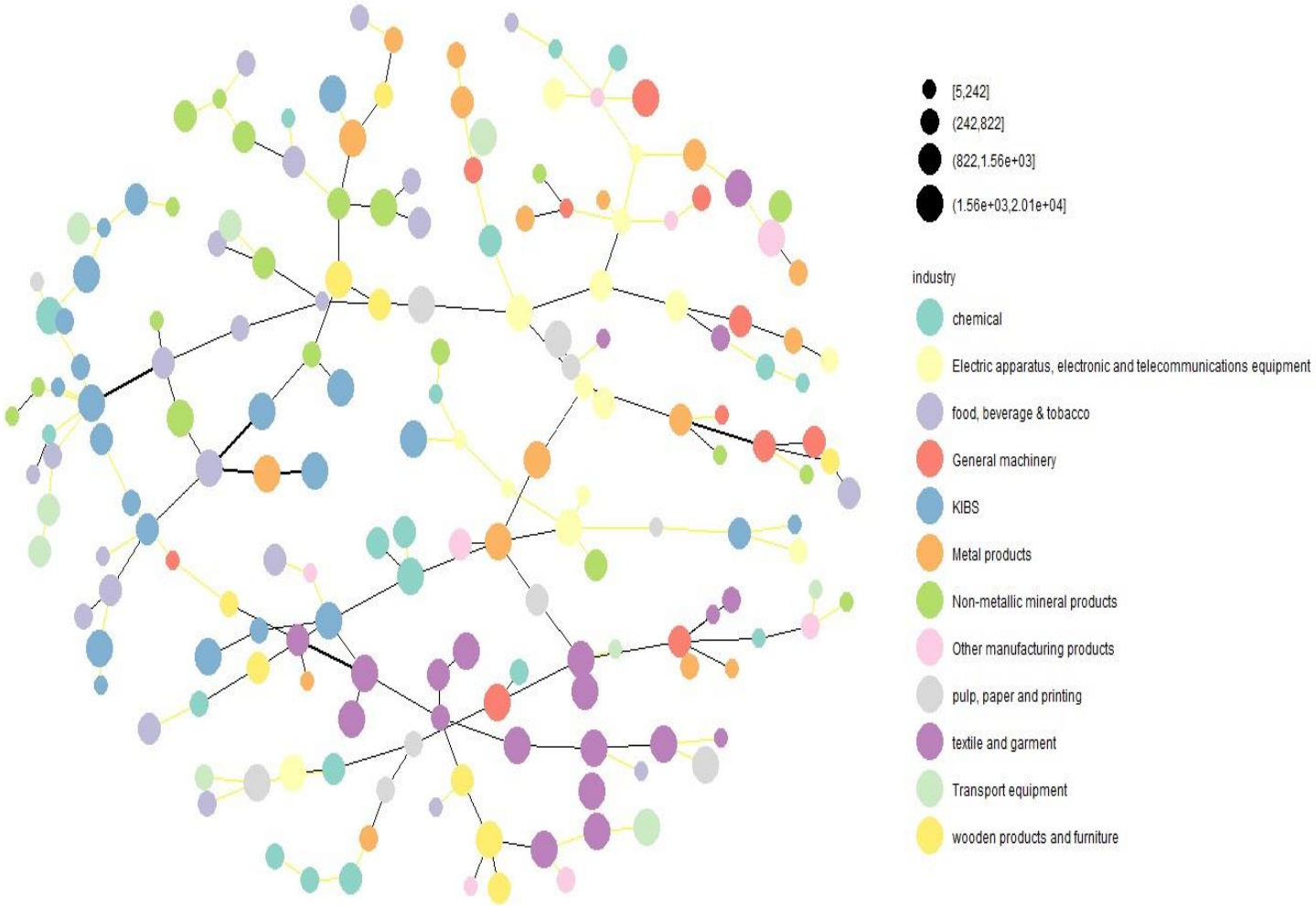
4.5.1. Relatedness measured in Tuscany: the Industry Space

In the last decades, the regional economy of Tuscany has seen a profound process of restructuring of the productive structure that is principally composed of two realities with very different historical dynamics The former is the presence of "traditional" system of industrial districts of the Made in Italy, which develops along the entire Arno valley starting from the Province of Arezzo to the inner part of the Province of Pisa and the latter is the presence of a high-tech industrial core centered on a few, but significant entrepreneurial presences and on an international scientific and technological research system, mainly concentrated on the three academic centres of Florence, Pisa and Siena. These two "faces" are in some cases present in the same territory and using an "agnostic" framework to depict the productive system represents a significant advantage to identify potential channels for growth and innovation.

Figure 5 represents the industrial space of the Tuscany Region for the year 2011, consisting of 181 nodes belonging to the manufacturing sector (NACE codes 10-33) and to KIBS (NACE codes 62-63 and 69-74). Each node of the network represents a NACE sector at 4-digit level and its size is given by how many employees each industry contained in the 2011 Census. In the network, the relatedness values represented in yellow mean proximity values between two sectors inferior to 0.5 (i.e. 50% co-occurrence probability), while the relatedness values greater than 0.5 are represented in black and the thickening of the tracer between the two nodes signifies a progressively greater proximity towards the 100%. The Industry Space representation confirms many productive concentrations, related to the specialisations of the industrial districts. The strongest connections occur in the internal network of sectors belonging to the fashion industry with proximity values between 0.6 and 0.7. Other traditional sectors of Tuscan manufacturing such as the manufacture of furniture has high proximity values (between 0.6 and 0.65) with 4-digit sectors within the "Manufacture of other non-metallic mineral products" (NACE code 23), such as glass, concrete and stone processing. The latter in turn finds a very high level of relatedness even with wooden manufacturing and furniture and engineering activities (values between 0.7 and 0.8). Good levels of proximity are also found within the food industries (values between 0.5 and 0.6), which find a discrete level of proximity with engineering activities. The manufacture of computer, electronic and optical products and the manufacture of electrical equipment with good levels of proximity to the paper and metallurgical sector and the manufacture of metal products. Finally, it should be emphasized that the KIBS internal network is very dense, having 40% of the KIBS network close to each other. The same indicators, if examined in an S3 lens, present interesting results. Even if the reasoning behind the construction of the two

remains "agnostic" with respect to the Technological Priorities, the picture that emerges is positive in terms of proximity between the sectors in some way attributable to the S3, which cover a central position within the network, thus performing the transversal function of "connectors" for which they had been identified as key development areas. The picture provided by the industry space is coherent to the typologies of results offered by this kind of methodology. The policy recommendations that can be derived from this approach are in line with the mapping tools shown in recent papers (see Balland et al., 2018). However, as it has been pointed out in the theoretical background, levels of proximity have different causalities (historical trajectories) and possible upgrading paths, which are not directly identifiable by the Industry Space, causing therefore some criticisms also in identifying the areas to be "zoomed" in the initial designing phase of EDP. The next section presents the main results of the interviews administered to TDs, with the aim to offer a complementary perspective on relatedness and the role of institutional entrepreneurs in favouring knowledge proximity.

Figure 5. Industry Space of Tuscany



Source: author's elaboration.

4.5.2. Main evidence from the interviews with institutional entrepreneurs: relatedness from a micro level perspective

Regional Government of Tuscany has defined 12 Technological Districts[29] (TD) related to crucial areas of the regional economy, such as fashion, paper, marble, photonics and robotics, cultural heritage, green economy and energy. TDs are composed of groups of economic and research actors with the aim to link firms and research centres in a systemic view, in order to create effective networks and enough critical mass to boost the competitiveness level of the supply chain of its own competence. The object of our analyses is represented by the 8 TDs that have prepared a strategic-operational plan[30], accompanied by a financial framework or a business plan. The strategic-operational plan presents actions and interventions planned to achieve the operational objectives of the TDs, such as:

- to stimulate the demand for innovation of the enterprises belonging to the TD and operating in the sector of reference;
- to facilitate the access of companies to technological knowledge and resources at national and international level, in their field of interest;
- to promote the sharing of research, testing and certification equipment and laboratories.

[29] TD are Indicated in the following publication of Decision of the Regional Government No 556/ 2014 (texts available only in Italian). Each technological district has typically a public-private governance with an organizational model consisting of a president, a steering committee and a managing body.
The District president is chosen from experienced entrepreneurs and/or managers and has the responsibility to ensure the coordination of the District's activities, verify the implementation of the strategic plan (that lead the activity and life of the District) and to act as representative of the District towards external entities.
The TD managing body can be chosen among a service centre for firms (with public, private of public-private form of organisation) and a consortium of firms. Its main tasks are to elaborate and implement the strategic plan of the district and to act as secretary agency.

[30] Provided for by the Decision of the Regional Government no. 789/2014 (texts available only in Italian). The strategic plan is a planning tool that contains:
a) scenario analysis through the use of statistical and qualitative data concerning firms, research centres, associations of the macro-areas of interest to the DT in terms of technological application within and outside the district and the relative innovation dynamics;
b) Strategic vision of the macro-areas identified in the medium-term perspective (2020) in terms of possible market scenarios, evolutionary trends, identification of potential synergies with other regional technological districts and connection with clusters and identification of the opportunities and risks (in terms of economic development and employment repercussion)
c) Strategic objectives based on the scenario analysis and evolutionary trends identified, evaluating realistically the regional territory and the possibilities for SMEs.
d) List of activities that are intended to be implemented within the operational framework, such as technological disclosure, production of strategic information (use of technological foresight methodology), activation of relations between companies and between companies and the R&D system.

Among their activities, TDs represent the main intermediate actors in the regional ecosystem that have participated to the process of entrepreneurial discovery. They have followed specific engagement rules, established by the Regional Government in order to obtain an "oriented contribution[31]" on the future opportunities of development for the technological domain represented by each TD.

TDs function as central conduits to provide information to affiliates in the technological transfer system and are natural "driving carrier" of knowledge exchange between the actors thanks to a set of action such as: continuous monitoring of its own affiliates and external actors ("know-what" and "why"); organisation of meeting between firms and between firms and research actors to increase the legitimacy and trust within the district ("know-who"); observing the tacit and explicit interrelation of different types of knowledge and its mechanisms ("know-how"). The face to face meetings with managers and coordinators of the TDs have allowed to describe with real examples the role of institutional entrepreneurs in developing the concept of relatedness at the micro level and on a multidimensional perspective.

TDs have the responsibility to collect relevant information and to explore future possibilities for their member groups. All the TDs, as "public animateurs", organise training seminars, investment forums, innovation challenges and matchmaking days to capture hidden signals (invisible statistical data). For instance, the matching days bring together firms, located in the same territory, which are involved in the development of new products or firms that produce technologies in a complementary direction, but that for some reasons have never established a contact. During these events, TDs managers and staff have the chance to closely observe their members, in order to understand their work aptitude and their nature, imagining possible business partnerships, future technology applications and new market needs. The degree of innovation culture among small firms pushes TDs to carefully detect the possible partners of a project and the possible result of the combination of actors with completely different mindsets and approaches in their work activities.

They encourage firms to participate in regional calls acting as "mediators" in the building process of partnerships with universities and research centres. In many cases, TDs have provided support to the

[31] The Regional Government of Tuscany coordinated the entrepreneurial discovery process, asking the TDs to provide independently an assessment of the potentialities and possible areas of discoveries. Each TD has proposed a document (available here) with the aim to map the internal technology scenario and proposing roadmaps to develop, individuating the expected targets. Each document has been reviewed by an independent team with expertise on policy evaluation, R&D projects, firms' incentives. After that phase, further workshops were promoted to debate openly their strategies, and a preliminary draft was produced. The final version was approved through an institutional validation (see the process represented in figure 6), which finally converged into the three technological priorities (ICT and photonics, Smart Factory, Chemistry and nanotechnologies) (Fabbri, 2016).

coordination and management of the various phases of the project. Some TDs have pointed out the difficulties of SMEs in capturing the logic of "one-shot one-kill" when presenting their proposal. Instead other TDs have underlined the efforts made by firms that participate to projects, given the importance to be global and connected, in order to be included in the supply chain ruled by big companies (as in the case of firms involved in robotics, medical devices, laser, ultrasound within the Life Science TD).

The major part of TDs outlines the members of the district in order to start the creative process of finding good partnerships, thanks also to unexpected connections. For instance, in industrial sectors related to Interiors and Design TD, many firms do not express innovation "per se" but need to apply new technologies in the sales system (product storytelling) and in the design phase of a product/service (e.g. augmented reality), while, given its traditional character, automatisation of industrial process remains still marginal.

In general, the connections nurtured by the TD depend on the nature of products and services and can assume diverse forms. To realise a yacht about 200 firms are necessary and the Nautical and Port Facilities TD need to think to the different typologies of firms involved (divided into production sites, repair shipyards, suppliers, service providers and harbor subjects) and what typologies can interact with external actors.

In other TDs, there is the possibility to range over a number of collaborations. Fashion TD is studying the possibility to apply textile to insulate improving the heat exchange between walls. In this case, there is an exchange and interaction between textiles, material treatment, construction sectors.

In other cases, the TD is based on a total cross-disciplinary action (within and outside the district). The Advanced Material district has introduced the theme of nano-remediation, such as technological solutions for the depollution of water, land and air through technologies based on advanced materials. An example is represented by nano-filters that remove impurities from water and mud taken from the dredging of canals. Another example is represented by the nanotechnologies used in the diagnostic phase of cancers: "markers" are positioned in the cancerous area that indicate with a target the area(s) where the medicine must act.

To enforce these connections, TDs have the fundamental task to establish a strong relationship with the territory, in particular with firms and universities. In many cases, the head offices of TDs are physically located in historical zones for the presence of natural resources or for the thickening of local competences and for a combination of the two.

As an example, the Marble and Ornamental Stones TD sees geographic, organisational and social proximity as pillars for entrepreneurial discovery and business development within the Apuan and

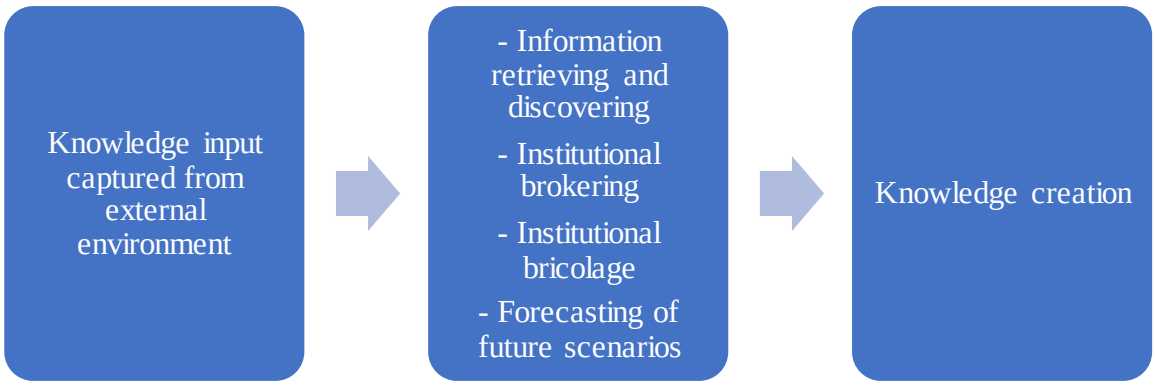
Versilia areas. The connections between subjects are the result of these types of proximity that contribute to supporting the development of a network that allows exchanges of knowledge, practices and uses. The complementarities existing between technology companies and those operating in the extraction and processing are very important, as the materials and machinery are designed, studied, updated in harmony with the user according to his needs.

According to some TDs managers the knowledge creation process is highly dependent on new forms of entrepreneurship, which can help to rejuvenate and transform capacities already existent within the district. Concerning this point the major part of TDs manager considers that start-ups should build their business model to support traditional firms, helping them to solve old issues and new challenges that for some reasons (mindset, resources, risk aversion) do not want to cope with alone. In the fashion world the big brands that control the market invest a huge quantity of resources to improve the efficiency of processes and in the marketing phase and the technical abilities of SMEs are often not perceived by the final user. New start-ups are perceived as a possible solution to fill this gap, such as in case of the Textile TD with the textile with sensors, and the multifunctional printing or recycled textiles for construction. During the conversation with the TD for Rail Technologies, High Speed, Safety and Security was mentioned an identification of development opportunities and market-oriented business model, referring to a German start-up that succeeds in the application of an integrated monitoring system designed for environmental purposes to observe the fall of plants on the train routes (called “free sentinel system”).

The majority of TDs managers have reported some barriers in the process of knowledge creation. The higher cost to validate a business idea (instruments and laboratory tests as in the cae of Life Science and Advanced Materials TDs) and the establishment of a common language across different structures are widespread examples reported by the TDs managers. In particular for the latter, some TDs have emphasised the lack of a direct channels of communication (even informal) between the academic and the world of firms. The high level of customisation required by the market requires high flexibility by the research institutions in terms of methodology and timing of action and a lack of purpose sharing can impede successful development of promising projects (as clearly described by the manager of TD Energy and Green Economy).

To summarise the findings, we schematise how TDs actions, visions and thoughts affect the process of knowledge creation, contributing to shape the level of knowledge proximity at a micro level (figure 6). Knowledge is absorbed by the TDs, which contribute to a continuous refinement of the local context, collecting scattered pieces of knowledge, mediating between universities and firms, building new capabilities and thus fostering the process of new knowledge creation at a micro scale.

Figure 6. How TDs shape relatedness at the micro level



Source: author's elaboration.

4.6. Discussion. In the intersection spaces between Industry Space and institutional entrepreneurship. What are the opportunities?

The results of the case study on Tuscany have allowed examining the EDP with a framework based on different lens of analysis, introducing also the subtended dynamics at a micro-level and how they are enforced by institutional entrepreneurs.

Despite the Industry Space depicts very well the traditional economic DNA of Tuscany, the validity of proximity level is questionable in its explanatory power. For instance, some connections that occur less frequently could have a more valuable exchange in comparison to others and the measure can be affected by the presence of big companies and two sectors could share market inputs, while others technological adoption. Therefore, co-location does not imply exchange and geographical proximity is not enough to explain innovation dynamics, as reported in the very well-known article on different types of proximity by Boschma (2005). Relatedness is not only a "one to one" relationship but also a "one to many" and "many to one" and can be mapped even in a multilevel perspective, consisting of different and parallel dimensions of the innovation system (Bessant and Rush, 1995).

Interviews with TDs have shown how the connections that lead to innovation do not take place automatically but are strongly influenced by the human agency component. In our case, TDs have been taken as an example of institutional entrepreneurs and what comes to light is that behind a connection there is an entire micro world, hardly enclosable in a dyadic proximity relationship. The

key message is that promoting a shared path creation, as in the case of EDP, is quite complex and even if two sectors are "related", the effective dynamics that intervene at the micro-level strongly affect the final outcome.

Each approach presents strengths and weaknesses, and the future approaches on innovation policy and foresight should try to integrate both qualitative and quantitative perspectives. Starting from the example of Tuscany, we imagine essentially two macro scenarios on the specific relationship Industry Space-institutional entrepreneurship (a,b) and a third "sub-scenario" on the general vision promoted by the strategy (c).

a) the Industry Space and the institutional agency "go in the same direction": the scanning of future opportunities and the roadmaps realised by the intermediate agents (in our case TDs) are sustained not only by the deep knowledge of actors but are also reinforced by quantitative evidence. The Marble and Ornamental Stones TD presents a focus on its plan on automatisation, optimisation of production processes and intelligent monitoring systems and the Industry Space express a clear proximity between the activity of cutting, shaping and finishing of stones and engineering activities. Another example is provided by the Life Science TD that emphasises in its plan the role of medical devices, diagnostic and drug delivery as main drivers of development and the Industry Space show good proximities between the manufacturing of pharmaceutical products and ICT (Computer programming and software realisation).

b) the Industry Space and the institutional agency offer a different framework: the vision of intermediate agents is not mirrored in the co-locations of the Industry Space or is partially represented. This can be interpreted in a double way. Firstly, the vision of institutional entrepreneurs can help to apply another unit of analysis or methodology to capture the proximities between regional domains. Taking the case of Fashion TD, the Industry Space of Tuscany shows a strong level of internal connections, which realistically represent the historical role of industrial districts. However, it does not account for possible fertile exchanges with the food and agricultural industries, which, according to the TD itself, represent a fundamental future fertilisation path to circular economy as the use of agricultural waste materials to produce new fibers and textiles. Secondly, the Industry Space can help the intermediates to individuate development useful funnels (or to avoid bottlenecks) that previously were not identified.

c) The general vision of the Regional Government in comparison to the central connectors of the Industry Space. Regional Government of Tuscany identified ICT and photonics, Smart Factory, Chemistry and Nanotechnologies as the three transversal priorities on which the strategy has been structured. The central nodes of the Industry Space in terms of betweenness are in line with the result

of S3 of Tuscany for what concerns ICT and photonics and Chemistry (manufacture of plastic, computer, electrical equipment), but Smart Factory is absent. This can be due to the properties of Industry 4.0 as a potential pervasive paradigm in terms of organisation and production processes for every business and therefore hardly enclosable in the concept of industrial sector. On the other side, the food production *filiere* and some textile and garment sector are important connectors with consistent parts of the network, but it has not been included between the priorities that can transversal communicate with important sub-part of the whole system.

4.7. Conclusions and implications for EDP

This chapter has analysed the EDP of Tuscany, using a mixed approach to improve the micro foundation of relatedness and the role of institutional entrepreneurs. The Industry Space has offered a snapshot of the possible channels where knowledge, competences, organisation models can "flow" and if mapped in different moments across times can offer insights on the evolution of industrial structures. The entrepreneurial agency, expressed by TDs, has allowed looking into the proximities, observing what mechanisms at the micro-level feed the innovation capacity of a region.

In the last decades, the importance of micro-level has fast emerged as a complementary one in regional studies and economic geography, which are trying to take into account institutions and politics as determining factors of the innovation level of a territory. This chapter contributes to the literature that raises the problem, but a "*theoretical blind spot"* remains in explaining the effective relationships between the micro and meso-level without keeping them in two separated spheres (Uyarra et al., 2017; Grillitsch and Sotarauta, 2019). Boschma (2005) posed relevant questions concerning the relationship between proximity and innovation, such as the connection between different forms of proximities (cognitive, institutional, organisational, social and geographical) and if these are substitute or to what degree they co-exist and if there is a prevalent one (Rossi and Russo, 2009). Quantitative analyses have tried to disentangle these questions, but important hints have been brought by case studies that have point out how related variety: (i) is continuously re-defined, (ii) follows discontinuous paths and (iii) is strongly influenced by global knowledge flows (Dawley, 2014; Bugge and Øiestad, 2015; Sotarauta, 2017). Therefore, the challenge remains to identify its causality.

Accordingly, the Product Space of Hidalgo et al. (2007) and its regional versions (as the Industry Space among the other) represent a meta-cognitive map of possibilities, without providing the "why" and "which", but assuming the proximity levels as the proxies of shared capabilities. In some terms,

these models neglect the process of quality upgrading and the diverse paths (and therefore use of different capabilities), which countries, regions and cities can adopt to obtain a similar result (Radosevic, 2017). Therefore, results of these tools need to be carefully interpreted in the light of an asymmetric vision of relatedness, not only in its mathematical formulation, but also as the vision of different possibilities of structural change, according to other hidden characteristics, able to qualitatively enrich the interpretative framework (Frenken, 2017).

In a global connected economy, a more insightful representation of the economic structure could be done with a bottom-up methodology based on their profound knowledge of the territory, starting from the supply chain of big players (in terms of clients and suppliers) and looking at the export dynamics (for the vocation of Tuscany) of SMEs to map the external connections, arriving to a concept of "extended regional branching".

The combinatorial knowledge process of EDP is demanding a profound digging of the invisible dynamics, avoiding to over account details, but focusing on the identification of strategic actors (and their power structure) that foster economic development (Sotarauta, 2017; Aranguren et al., 2019).

Unfortunately, linear model of innovation (even unconsciously) endures to be the more adopted in policymaking, taking for granted that the three-helix model (universities, companies, research centres) work in every context, praising successful stories and modelling a distorted storytelling on innovation, as it would follow the same script (Marques and Morgan, 2018).

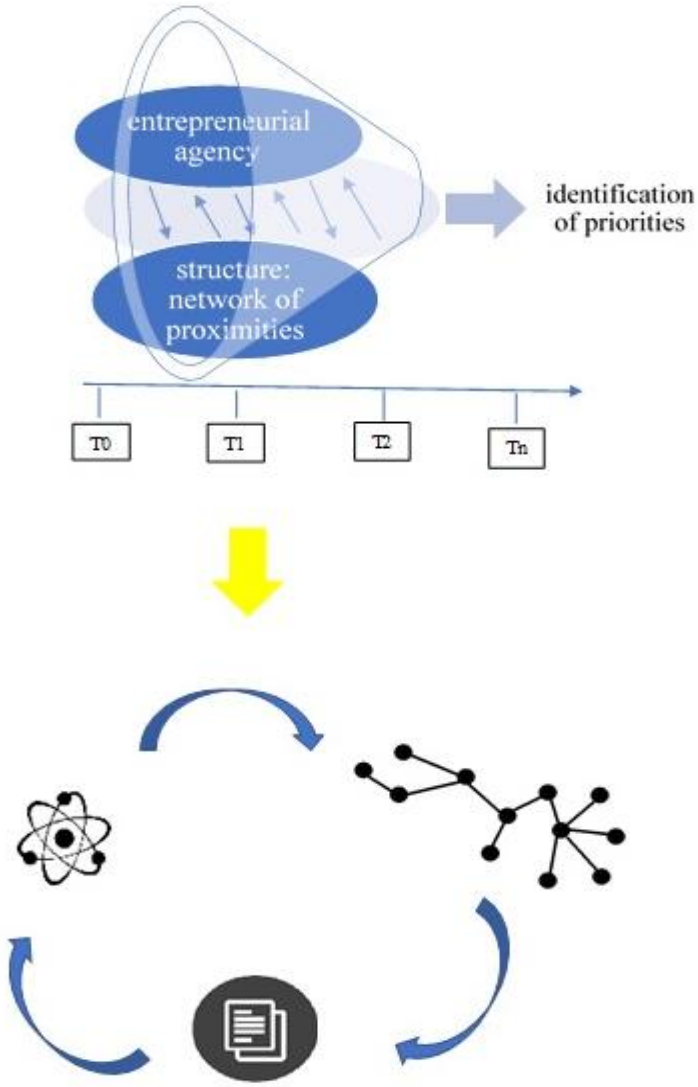
Almost twenty years ago, Kirat and Lung (1999) described innovation as a "problem-solving oriented process", in which cognitive models shared among the main actors that participate in the innovation process can help to frame the learning space. These models need to be a "non- homogeneous cognitive representation" that is interpreted and adapted by agents, which that in turn are shaped by them in their understanding of realities, in a hybridisation process that merge the old routines with emergent properties (Kirat and Lung, 1999; Rossi and Russo, 2009; Sotarauta and Suvinen, 2018).

Notwithstanding the fresh awareness that micro behaviour and evolution of industries should be described as two sides of the same coin, policy indications remain quite assertive and based on fuzzy mainstream slogan (bottom-up, place-based, place-sensitive, one size fits all) that try to simplify concepts highly complex and articulated on a multi-level perspective (Uyarra, 2010; Uyarra et al., 2017). This, in turn, leads to treat policymakers as the "*passive recipient of unproblematic and straightforward translated recommendations"* (Flanagan and Uyarra, 2016, p.178) and to superficially analyse *"policy instruments as discrete, stable and straightforwardly implemented tools"* (Uyarra et al., 2017, p. 561). Analytical framework and relative instruments should evolve, keeping in mind the "*irreducible uncertainty"* (Flanagan and Uyarra, 2016) and considering agency

not “a qualitative frill” but as cornerstone of a distributed process and part of the experimentation of the entrepreneurial discovery (Uyarra et al., 2017). Hereafter we propose a cognitive framework to synthetise EDP a continuous and interactive relationship between the structure and actors.

Figure 7 shows a scheme to summarise this idea, representing the EDP as the duality of structure and agency that evolves from the initial period (T0) to the end of the strategy (the identification of priorities in Tn) according to the funnel approach, narrowing the possible choices, as in the EDP logic. What happens in the funnel is figured in the lower part of the picture who shows a recursive feedback loops using the metaphor of atom and molecular structure to represent respectively agency (as firms and institutional entrepreneurs) and cognitive space of connections (as endowments of a region in terms of innovation potential) entrenched in a nested relationship and producing matter that in our case is a shared policy plan containing the “discoveries” (the priorities identified, which can change during the process).

Figure 7. The EDP as the interplay between agency and structure



Source: author's elaboration.

5. Entrepreneurial styles and knowledge integration: meeting the challenges generated by Smart Specialisation Strategy. A focus on Tuscany.

5.1 Introduction

Smart Specialisation Strategy (henceforth S3) and *Entrepreneurial Discovery Process* (EDP), the main policy tool through which the strategy is effectively designed and implemented, have recently attracted the attention of many scholars. Almost five years have passed since the implementation of S3 plans and it has emerged the need to analyse not only the so-called institutional entrepreneurs (as regional governments or technology transfer agencies), but also the "real businessmen" as micro agents of change. Accordingly, Henning and McKelvey (2018) pose some relevant questions for the future of S3: the characterisation of entrepreneurs in the current economic scenario, the criteria to define successful entrepreneurs and their relationships with the business environment.

Since its first theoretical definition, entrepreneurship has been identified as an activity of knowledge integration and experimentation in relation to the internal and external environment (Kerr et al., 2014). Nonaka (1994) points out that innovating can be configured as a continuous activity of problem-solving and information processing, into which different systems are connected through the integration of tacit and explicit knowledge. This view of entrepreneurship was introduced also in the debate on the relationship between the role of entrepreneurs and the local development by Becattini and Rullani (1993), who adopted the concept of "*versatile integrators*" to describe "single or group of men who use competences sedimented across time, embedded in specific local context". These men, for most entrepreneurs, were able to de-codify knowledge related to products, machines and tools, acquired by personal experiences, re-codifying it in different ways. Becattini and Rullani (1993) described these figures as able to nurture the cognitive capacity of the district and thus crucial to foster the process of regional development, using a trial and error to discover new business opportunities, with a mental framework mainly oriented to the set of possibilities offered by the local context where they lived.

In the last decades, as stated by Buciuni and Pisano (2018, p.1069) "t*o remain competitive in today's globalized economic scenario, regions and firms need to continuously upgrade their capabilities in global value chains".* The availability of information has exponentially increased and their cost has drastically decreased, thanks to the pervasive force of digital networks and cloud

computing. These elements, summed up to enormous advancements in human knowledge, have radically changed the way into which knowledge is experimented and integrated (Kerr et al., 2014). In the complexification of production processes, the set of possibilities to explore has become endless, making harder for single entrepreneurs to possess all the knowledge necessary to start or scale-up their businesses. In this cyber-physical environment, realising performant products requires the development of a dynamic cognitive system able to decompose the structure of problems, considering systemic interdependences that affect it (Simon, 1973; Gardner, 2011; Henriksen et al., 2014; Gemmell, 2017).

Accordingly, a new tendency in entrepreneurship is emerging around the archetype of the "expert generalist", who represents an agent with the capacity to understand, up to a certain degree of depth, various types of knowledge, and combine them together, if a possible pattern of development is recognised. In the current techno-economic scenario where the complexification of production processes is increasing and products are "multi-technology", firms composed by "competent teams" (Eliasson, 1990) are strategically coordinated by these entrepreneurial figures that constitute fundamental "micro pieces" in the scanning process of future opportunities of regional development (Secundo et al., 2015).

This point has been not exhaustively discussed in the literature that addresses S3 nor in the more general literature that crosses entrepreneurship and regional science.

The aim of the paper is thus to study a bunch of entrepreneurs as integrators of different sources of knowledge, in the attempt to individuate the emerging properties of these figures and what role they can play in the regional structural change promoted by S3. In particular, this conceptualisation of entrepreneurs as (re)combinators of knowledge, matched with the huge increase of information, results in unpredictable patterns of economic development, which automatically became by default experimental (Johansson, 2010), offering interesting stimuli to debate future EDPs.

The methodology adopts a qualitative approach, using semi-structured interviews administered to a selected set of entrepreneurs in Tuscany. The idea is to gather data codifying them with the help of Gioia methodology (Gioia et al., 2012) in order to derive some characteristics of the entrepreneur and the firms to describe emerging properties. Then a ladder of entrepreneurial styles is presented to classify the emergent properties into entrepreneurial archetypes, which are defined with the help of the research work conducted by Dennet (1996), a well-kwown American philosopher in the field of evolutionary biology and cognitive science.

The paper is structured as follows. Section 2 presents the theoretical framework. Section 3 illustrates the Research Design. Section 4 displays the result of the research. Section 5 discusses the findings,

advancing the proposal for a tower of typologies of entrepreneurs. Section 6 offers some final remarks and policy implications for S3 and EDP.

5.2. Theoretical framework and research question

5.2.1. Towards a new model of the entrepreneur as knowledge integrator

The role of entrepreneurs in the process of knowledge integration and recombination was firstly recognised by Schumpeter (1934), who describes entrepreneurs as those individuals able to carry out new combinations of means of production and credit[32]. In *The theory of the growth of the firm* by Penrose (1959), some passages evidence the role of "*entrepreneurial services"* as "*contributions to the operations of a firm of new ideas"* referred to current production but also to changes and future plans. In the same book, Penrose expands these concepts with the idea of *"entrepreneurial versatility",* intended as the "*the quality of imagination and vision*" and describe the ability of entrepreneurs to imagine the future horizon of a firm (composed by *imaginative effort, sense of timing, instinctive recognition*). Many years later, the research work of Ikujiro Nonaka on knowledge creation develops the idea of integration and combination of knowledge, adding other fundamentals pieces to understand these dynamics within firms. The most important contribution by Nonaka refers broadly to the mechanisms of knowledge creation within firms. The author presents a fundamental model in which tacit and explicit knowledge are combined and integrated into a spiral, which involves transversally all employees in the definition of problems and development of new knowledge to solve them (Nonaka, 1994). Accordingly, firms are continuously involved in a process of self-renewal respect to existent routines and new ideas arise from the questioning of rooted physical, virtual and mental shared space (Nonaka, 1991; Nonaka and Konno, 1998).

This streams of literature on knowledge creation has been purposely inserted in the local development approach by the work of Becattini and Rullani (1993), which highlights how the continuous interaction between tacit and explicit knowledge shapes codification and de-codification of knowledge within industrial districts and local systems. Becattini and Rullani (1993) underline the role of entrepreneurs as crucial engines in the process of knowledge creation and integration in local contexts, defining them as "*versatile integrators",* able to combine different sources of knowledge in

[32] It is necessary to remember that entrepreneurs for Schumpeter "*do not form a social class in the technical sense",* but are those individuals or group of individuals that carry out the process of new combination. Therefore, even managers, financiers and promotors can be defined entrepreneurs in his theoretical approach.

the firm: with a "mind's eye" effort they apply mental framework to imagine (codification and de-codification) the use and organisation of resources/activities in many different contexts.

Versatile integrators are single or group of men who acquired by personal experiences competences sedimented across time, embedded in specific local contexts, therefore linked to the historical process of local thickening of knowledge and information. Many years have passed since the introduction of the concept of the *versatile integrator* and in the meantime human knowledge has impressively become more "complex and global". As a matter of fact, Becattini and Rullani (1993) discussed the local-global circuit of knowledge, but the current techno-economic scenario shows dynamics that have completely reshaped the entrepreneurial environment and hence the function of the entrepreneur.

Since the nineties, it has been acknowledged that the growing set of possibilities have fostered the experimental nature of entrepreneurship, not only because of the bounded rationality a là Simon (1991) or the dispersion of knowledge a là Hayek (1945), but also because a complexification of production processes has substantially changed the economic game (Eliasson, 1990; Kerr, 2014). Some stylised facts can be reported as determinants of this change of perspective:

- The products have become multi-technology, creating separated but interconnected niches of specific technical knowledge;
- the strategic horizon of the firms has strongly speeded up and complexified (lower costs of information exchange, but at the same time larger cost to convert into knowledge this increasing amount of information);
- the competitive environment has become extremely open ("open innovation paradigm") and global.

In this context, innovation processes are subject to global structural transformations, which influence the absorptive capacity of external knowledge by the firm (Strambach and Klement, 2012).

Products are becoming smart, because they tend to integrate physical with digital components and innovation is becoming mainly driven by combinations of diverse knowledge bases, which define the "technology stacks" of the firms that need to evolve relentlessly to face emerging productive and socio-economic needs (Lombardi, 2018).

Arthur (2009) in the final part of his book "*The nature of technology: What it is and how it evolves"* brilliantly frames this paradigm's shift in economy remarking epochal changes that are occurring:" *from optimization to creation of new combinations, new products and new functionalities; from rational choice to sense-making, from commodity based company to skill based company; from the purchase of component to the formation of alliances; from steady state operations to constant adaptation"* (p.210).

Recently the issue on how to collocate entrepreneurs as knowledge integrators has been faced by Buciuni and Pisano (2018) who define a knowledge integrator as

"*a locally operating lead firm that, by pursuing a constant product and process innovation strategy through the integration of global market and local technical knowledge, stimulates the continuous upgrade of cluster suppliers and supports the preservation and improvement of local external economies"* (p.1071).

This definition brings the attention to the need for incessant improvements to keep up with the overlapping of global information and cognitive domains, a model which emphasises the emerging importance to integrate knowledge, in a new fluid landscape, where core competences, based on the ability to set external search strategies, incorporate specific purpose technologies (West et al., 2006; Martini et al., 2017).

However, considering this definition of knowledge integrator, it seems necessary to deepen some points already raised in order to expand the characterisation of the entrepreneur as knowledge integrator and its environment, surrounded by a growing uncertainty given by local (such as the institutional functioning and the business rules) and global conditions (such as geopolitical and climate issues). These elements can be grouped into three different (but linked) spheres: a) the new dialectic between local and global contexts, b) the experimental features of entrepreneurial activities, c) an open entrepreneurial mindset.

The first point indicates that in the current scenario, creation and integration of new knowledge can infrequently be explained only as the recombination of knowledge at the local level, many global circuits enter in different phases of productive and/or organisational processes (Bathelt and Cohendet, 2014). Doz et al. (2001) define the new challenge the ability to innovate linking scattered pieces of knowledge dispersed across the world. Concerning that, they define *metanational* those firms equipped with a "*sensing network*", mobilised to coherently unravel among an enormous set of possibilities in a logic of discovery new competitive advantages, learning from the world (Doz et al., 2001; Williamson, 2007). Therefore, the legacy between global and local circuits of knowledge is no more only integrated thanks to the direct experience of the entrepreneur, who previously elaborated the various inputs. Nowadays, owing to the presence of diffused online networks the entrepreneur can coordinate an internal team of experts (even remotely) and/or external knowledge brokers and gatekeepers (Malecki, 2010), who represent "the extended branches" of the knowledge integration and recombination process.

The second point concerns the possibility to have an "experimental framework" within which entrepreneurs can think and act, essential to transforming knowledge into economic knowledge (Lindholm-Dahlstrand et al., 2018). Accordingly, Kerr et al. (2014) point out the necessity to

distinguish between the well-known market test and the micro-level process of experimenting by bringing "new food for thoughts", because many peculiarities of the experimental process cannot be known in advance (Rosenberg, 1992). Experimental does not mean by chance but an attitude towards learning, trial and error approach and adoption of an open innovation paradigm, considering competition between incumbents and between new firms and incumbents (Eliasson, 1990; Bessant, 2008). Having an experimental framework implies a structured pool of human capital able to manage information, learn and perceive in advance technological opportunities (Cusolito and Maloney, 2018). This entrepreneur can be placed at the centre of this process, acting individually or more probably relying on heterogeneous knowledge sources, coming from different social structures (Grillitsch, 2019). Nowadays there is a completely new set of tools to effectuate this activity of discovery and experimenting (e.g. cloud computing, artificial intelligence, IoT, just to name a few), which are forcing entrepreneurs and their networks to continuously increase their ability to learn and to integrate this trial and error approach in their firms 'routines (Bessant, 2008; Cusolito and Maloney, 2018).

The third point refers to the importance of owning an entrepreneurial mindset (not in general terms, but fitted to a discontinuous and changing scenario). This issue can be introduced quoting Arthur (2009, p.210): "*Entrepreneurship in advanced technology is not merely a matter of decision making. It is a matter of imposing a cognitive order on situations that are repeatedly ill-defined".* The coordinates of the techno-economic evolution have a blurred horizon with undefined borders, therefore there is more need to create and integrate different sources of knowledge in an uncertain and shifting environment (Haynie et al., 2010). The entrepreneurial mindset is a metacognition problem as a *"reflective state of mind"* (Noble, 2016) and *"thinking about thinking"* (Naumann, 2017). In economics terms entrepreneurial mindset is not only the tool to pursue experiments but also to set a heuristic strategy to disentangle complex situations, reacting rapidly to uncertainty and thus reducing costs (Noble, 2016; Haynie et al., 2010).

The three elements above described are naturally interrelated because entrepreneurs with open entrepreneurial mindsets are able to move in the local-global dialectic setting proper experimental framework. Of course, the experimental framework constitutes the ecosystems from which new entrepreneurial ideas come from. These frameworks are in turn influenced by the innovative features of the milieu, by the relationship between the global-local circuits.

Teece (2019) claims that the comprehension of the current economic world passes through the understanding of firms' mechanism in terms of transformation, learning and strategic coordination in an environment characterised by deep uncertainty, small and frequent shocks and full of hidden

connections to reveal (Teece, 2019). To trace the coordinates of this fuzzy scenario the inclusion of the dynamic capabilities of firms is crucial:

"*(1) identification and assessment of threats, opportunities, and customer needs (sensing); (2) mobilisation of resources to address fresh opportunities while capturing value from doing so (seizing);and (3) ongoing organizational renewal (transforming)"* (Teece, 2019, p.10).

So, from these elements, what entrepreneurial figure emerges in terms of knowledge integration?
The current technological scenario is defining *"an open language for the creation of structures and functions"*, which have the properties to be combined and recombined "*endlessly for fresh purposes"* (Arthur, 2009). The huge increase of diverse (and specialised) types of knowledge integrated into single production processes makes gruelling the presence of an entrepreneurial figure able to know all the details of products, components, design. Moreover, it has become quite complicated to compare new knowledge to previous knowledge by merging it with previous cognitive structures, because of the difficulty to identify pre-determined categories of analysis, considering the "*deep uncertainty*" which makes unpredictable the internal and external environment (Rullani, 2004; Teece, 2019).
In a nutshell, there is a high degree of cognitive diversity in the process of knowledge integration and combination (Nooteboom, 2000; Stramabach and Klement, 2012). "To get out from the jungle" are emerging new figures with the capacity to broadly de-codify the complexity products, processes and functions and re-codify them in simpler terms, able to see unusual connections between related or unrelated domains of knowledge in an open exploratory approach.
This refers exactly to the case of the "*expert generalist*[33]", who represents an entrepreneurial agent with the capacity to understand, up to a certain degree of depth, various types of knowledge, and combine them together, if a possible pattern of development is recognised. These kinds of figures are emerging as the ones that will survive and outstand in uncertain economic scenarios, feeding the innovation systems (Malerba and McKelvey, 2018).

[33] About this point it is interesting the work of Berta (2018) called "*l' enigma dell'imprenditore*". Berta underlines that not all the iconic cases of entrepreneurs emerged recently can be ascribed to such a paradigm of "expert generalist". Elon Musk and Mark Zuckerberg belong only apparently to the same category of entrepreneurs. On one hand, Zuckerberg has exploited an opportunity left by incumbents, using digital network to connect people. On the other, Muck has set an multi-knowledge exploration strategy to connect things, apparently not associable: the three firms owned by Musk (Tesla, Space X, Solar city) are part of a single innovative process, exchanging continuously knowledge and information relative to materials and technologies employed in the production processes and its design. A concrete example come from the Tesla cars that are not only a new kind of car, but products inspired by heterogeneous and exogenous criteria in comparison to the traditional car industry development (Berta, 2016).

5.2.2. What role for the entrepreneur as knowledge integrator in Smart Specialisation Strategy?

Smart Specialisation Strategy (S3) describes "*the capacity of an economic system (a region for example) to generate new specialities through the discovery of new domains of opportunity and the local concentration and agglomeration of resources and competences in these domains"* (Foray, 2015, p. 24). S3 represents a process of transition towards a new scenario with very intense innovation rhythms and experimentally organised around the discovery of new promising domains. The EDP allows to set a proper exploration strategy thanks to the engagement of a plethora of actors such as local governments, R&D lab, firms, universities and associations (Foray, 2015). The process of discovery consists in the consultation of these actors in various steps, following a "funnel approach" to channel the possible technological domains to prioritise. To conduct this activity, Foray highlights the need to set a proper level of "granularity", between macro and micro level of activities and avoiding to focus on innovation undertaken by individual firms (Foray and Goenaga, 2013; Foray, 2016).

To this extent, the focus on entrepreneurs as knowledge integrators can be at first sight "inappropriate" with the final aims of S3. However, as pointed out by Becattini and Rullani (1993), industrial evolution cannot be analysed and addressed if *versatile integrators* are not taken into consideration in their peculiarities. Therefore, the shifting entrepreneurial paradigm, towards which our societies are moving, needs to be enclosed in a conceptual framework able to explain the micro-foundations of regional transformation, crucial for S3 (Henning and McKelvey, 2018). Enterprises are micro-pieces of economic development (Schumpter, 1934), and the knowledge combinations implemented by these micro-entities are multi-scalar in nature and crucial for regional structural change (Strambach and Klement, 2012; Grillitsch, 2019). Scholars are suggesting the importance to understand the combinatorial dynamics of knowledge at the micro-level and the mechanisms through which this activity is carried out as puzzling questions for policymaking (Buciuni and Pisano, 2018; Fritsch and Kublina, 2018).

The consequences are for firms, their organisational forms and their boundaries, but also for the intermediaries in knowledge transfer connected to them and involved in knowledge creation, diffusion and use (Malerba and McKelvey, 2018). For instance, knowledge brokers, R&D centres, universities need to evolve and adapt, being keen on the modularity of products' knowledge bases, taking into account the huge amounts of scattered information, which influence the way into which innovative products or services are developed and the predatory global competition. This "systemic

contagion" can have a tremendous effect on the process of discovery as described in Foray's book. Structural changes, posed at the centre of S3 debate, can be conceived as sequences of trial and error micro spots, which can converge into "a critical mass" which traces a path of local development. Hence, in this perspective, the evolution of the whole economic system is a matter of "*experimental creation of a variety of ideas"* (Carlsson and Eliasson, 2003). This is the approach offered by the *Experimentally Organised Economy,* a concept introduced by the research work of Gunnar Eliasson, which basically illustrates economy as a "*decentralised endogenous allocation of human or team embodied competence*" (Carlsson and Eliasson, 2003). The assumptions on the endless space of possibilities to create different pattern is articulated in three parts: (i) the entire space of creation is not completely visible by the actors (including the central government), because knowledge is dispersed and humans are limited in their capacity; (ii) there are possible business solutions that are unknown but superior to the actual ones; (iii) this space constantly expands thanks to internal digging and open learning, so mistakes are constantly revealed (Carlsson and Eliasson, 2003). The theoretical framework of *Experimentally Organised Economy* brings the attention to the evolutionary process of discovery, emphasising how economic systems can be seen as a chain of activities, carried out by each "*competence bloc*" (Johansson, 2010). Competence bloc refers to the total "infrastructure" necessary to create, select, recognise and exploit new ideas. In these "discovery-driven regimes" where external conditions are uncertain, resources are unequally distributed in quality and quantity solutions are experimentally discovered rather than planned in advance, entrepreneurs as knowledge integrators can mobilise different resources, spreading them in multiple directions (Carlsson and Stankiewicz, 1991; Lindholm-Dahlstrand et al., 2018).

5.3. Research design

5.3.1. Research aim

The comprehension of the current industrial evolution passes through the understanding of firms' mechanism in terms of transformation, learning and strategic coordination, which in aggregated terms contribute to the development of regional trajectories. The entrepreneurial approach presented in the previous sections matches with the logic to assign a new role to entrepreneurs in the process of structural change. As pointed out across the paper, the function of the entrepreneur as combinator of various kinds of knowledge is shifting, because of the changing nature of products, global evolving scenarios and speed and volume of information. The capacity to coordinate multiple

domains of knowledge up to a certain "breadth" and "depth" (Ozman, 2010) is testing the entrepreneurs' ability to evolve and adapt to the environment. In addition, analysing firms contributes to grasp evolutionary steps in fieri, in other words, to capture the new thresholds of the real industrial system (Vaccà, 1989). Accordingly, Foray (2018) underlines that S3 describes firms as micro founders of regional structural change, which is supposed to take place thanks to economic experimentation through "*entrepreneurial vision*", "*integration of knowledge*" and "*entrepreneurial capabilities*". These ingredients can help to explain the micro-foundations of regional transformation and therefore to describe EDP at the micro-level. The aim of the paper is to answer to the following questions:

1) Can we define specific characteristics of entrepreneurs as knowledge integrators in the current techno-economic scenario?

2) What are the policy implications for the Entrepreneurial Discovery Process (EDP) within the S3 framework?

After the results' discussion, the final aim is to propose a ladder of analogical entrepreneurial typologies, able to group the specific characteristics of the entrepreneurs. Starting from the key messages that emerged by this ladder, in the final section are presented the implications for a distributed technology transfer model, which actively relies on this entrepreneurial figure to improve EDP design and S3 implementation.

5.3.2. Methodology, data selection and data analysis

The fuzziness of the entrepreneur as knowledge integrator in the current techno-economic scenario makes hard to adopt a clear-cut conceptual framework, therefore the Grounded Theory of Glaser and Strauss (1967) based on the inductive potentiality of data seems the research strategy more adequate to use (Eisenhardt, 1989).

Given the aim of the study, it is adopted a qualitative methodology based on semi-structured interviews, which permits to deeply explore the role of entrepreneurs and the processes of knowledge creation and integration (Arbuthnott and Friedrichs, 2013; Butzin and Widmaier, 2016). The outline of the interviews consisted of three building blocs:

(i) the background of the entrepreneur and the genetic process of the firm[34]
(ii) the external competitive environment: coordinates of the techno-economic scenario[35]
(iii) the business model and the information structure of the company including a double environment, internal and external (internal and external)[36]

These three parts contain questions aimed to bring out the capacity of the entrepreneur to integrate knowledge and coordinate resources, stressing the consequences on the firms' decisions and strategies in an uncertain and quickly evolving scenario. The selection of the sample was based on the criterion of "*purposeful sampling"* (Patton, 1990), a non-probability sampling, applied also to entrepreneurship studies (Neergaard, 2007). Our purpose was to research information, which can help to delineate the theoretical framework, without the presumption to generalise our findings.

The *purposeful sampling* was designed with the help of "key informants", the Technological Districts and Confindustria Toscana Sud, chosen for their direct involvement in Tuscany S3 and for their extensive knowledge of the most dynamic firms on the territory. Digging in the network of our key informants, we selected a bunch of firms in manufacturing, ICT and engineering, oriented to innovation and positioned on the techno-economic frontier, and we interviewed 24 entrepreneurs, until the reaching of theoretical saturation. Data collections took 5 months and the interviews lasted on average from 1h to 1h and 45 minutes.

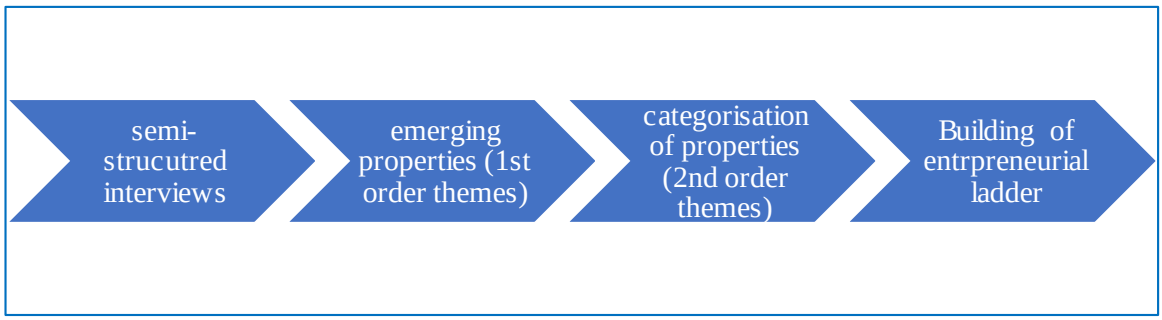
[34] Example of questions relative to bloc one:
- At what age did you become an entrepreneur?
- Did you inherit the company or founded it?
- In case you found it, did you conduct the trial alone or with other people?
What is your educational background? (in case there are more members, what is their background?)

[35] Example of questions relative to bloc two:
- Can you define the innovative intensity of your target market?
- How does your company react to the innovative intensity of the context? (e.g. investments in machinery / equipment, upgrading of internal skills, strategic alliances)
- Can you mention some of your most important partnerships and the reasons that prompted you to do them? How many of these relationships are regulated through formal agreements? How many informally?

[36] Example of questions relative to bloc three:
- How is the company organized in terms of functions and modes of production?
- Are there managers inside the company?
If yes, what is your relationship with them (in terms of vision, strategy, decision-making)
If not, how are the strategies and decisions taken? How do you coordinate the different levels?
- What kind of innovation has been introduced in the last 3 years? Why?
- What are the learning sources of the company?

Following the approach of Bucioni and Finotto (2016), we employed the Gioia methodology (Gioia et al., 2012), which is mainly articulated in two phases. In the first phase (called "1st order"), concepts and ideas of the interlocutors (the entrepreneurs interviewed) were taken out from the interviews. In the second phase (called "2nd order") the 1st order extracts were codified with the help of previous knowledge into different categories, using "research-centric concepts, themes and dimensions" (Gioia et al., 2012). Finally, the identified categories were aggregated into different patterns in order to define the different entrepreneurial styles according to what emerged from the fieldwork results. The categories emerged from the fieldwork results were grouped through a conceptual clustering in a ladder of entrepreneurial typologies according to the strategical exploration degree. The Gioia Methodology is in line with the perspective of Grounded Theory and allows us to see the connection between the informants' perspective and researchers' point of view, "defining hallmark of high-quality qualitative research" (Gioia et al., 2012).

Figure 8. methodological steps



Source: Author's elaboration

5.4. Results

Our sample (showed in table 9), containing almost all SMEs with very different performances (from 1 to 209 € millions of turnover) and structures (from 5 to 427 employees), distributed on 5 provinces of Tuscany, has allowed to observe the role of the entrepreneurs, across different industrial sectors, comparing several times insights from the emerging literature with the results of the interviews in a theory-building logic perspective (Yin, 2018).

Table 9. the sample of the firms interviewed

Pseudonym	Date interviews	employees	ATECO 4 digit	Description	Province	participation in regional projects
1	06/03/2019	180	2830	Manufacture of agricultural and forestry machinery	Arezzo	yes
2	08/04/2019	9	1310	Preparation and spinning of textile fibres	Prato	yes
3	10/04/2019	47	6311	Data processing, hosting and related activities	Florence	yes
4	11/04/2019	197	2561	Treatment and coating of metals	Arezzo	yes
5	11/04/2019	56	3212	Manufacture of jewellery and related articles	Arezzo	no
6	12/04/2019	20	1320	Weaving of textiles	Prato	no
7	16/04/2019	15	2651	Manufacture of instruments and appliances for measuring, testing and navigation	Florence	yes
8	16/04/2019	64	1520	Manufacture of footwear	Florence	no
9	24/04/2019	427	2920	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	Siena	yes
10	10/05/2019	19	3102	Manufacture of kitchen furniture	Pisa	no
11	13/05/2019	20	3101	Manufacture of office and shop furniture	Siena	yes
12	14/05/2019	68	3109	Manufacture of other furniture	Florence	yes
13	23/05/2019	35	2651	Treatment and coating of metals	Siena	yes
14	27/05/2019	19	2829	Manufacture of other general-purpose machinery n.e.c.	Florence	no
15	29/05/2019	15	2454	Casting of other non-ferrous metals	Siena	yes
16	04/06/2019	42	2893	Manufacture of machinery for food, beverage and tobacco processing	Siena	yes

17	04/06/2019	5	3109	Manufacture of other furniture	Siena	yes
18	10/06/2019	136	2892	Manufacture of machinery for mining, quarrying and construction	Siena	yes
19	11/06/2019	56	1102	Manufacture of wine from grape	Siena	yes
20	17/06/2019	80	2511	Manufacture of metal structures and parts of structures	Siena	yes
21	18/06/2019	74	2410	Manufacture of basic iron and steel and of ferro-alloys	Florence	yes
22	01/07/2019	7	2910	Manufacture of motor vehicles	Siena	yes
23	01/07/2019	64	1621	Manufacture of veneer sheets and wood-based panels	Siena	no
24	05/07/2019	52	2711	Manufacture of electric motors, generators and transformers	Siena	yes

Source: author's elaboration

In this section we report the results found out from the overall analysis of the interviews, looking in particular at what can be the insights to update the theoretical framework.
The Deutsche Bank Research report on Innovative Minds by Dapp (2009) presents some interesting elements related to the innovation process. This gave us the opportunity to organise the results of the interviews around some generic themes.

a) Man as the most important resource in the innovation process: the centrality of mind

Almost all the entrepreneurs have decisively pointed out the role of knowledge and its increasing value in the design and realisation of products and services without distinction across sectors. The entrepreneurs interviewed had very different background and previous experiences, but many of them showed tenacity and passion for learning (even completely different subjects), as reported hereafter:

"After the company where I worked went into liquidation, I started to do sell colour televisions and in the meantime, I began to study self-taught software" (RESPONDENT 1).

"Oriented by the problems I found on workdays, in the evening I went to the nearby library and, driven by the engine of curiosity, I tried to figure out by myself the mechanism of research. I applied the findings in the morning. And this pattern has repeated until the coming of web search tool" (RESPONDENT 7).

A curious mind is, therefore, a strategic asset to deal with the continuous updating of knowledge frontier. All the entrepreneurs with and without the technical knowledge recently engaged with the task to continuously monitor and rethink the production's process, scanning several internal and external inputs and translating them into new feed for the firm. For instance, those with technical knowledge were pushed to disengaged by a too specific and bounded perspective, looking for general scenarios, while entrepreneurs less equipped with technical knowledge, did the opposite effort. All the interviewed underlined the necessity to be ready for sudden changes "on the fly" for what concerns the organisation of work and designing phases, maintaining a high-quality standard level. To face this challenge doing research is a key action, which has been described as strategic:
"I have recently hired an electronics engineer only to monitor the latest trends and to conduct research through a simulation software" (RESPONDENT 24).

b) Multidisciplinary cooperation as a strategic asset

Many of the interviewers stressed the importance to consider the R&D department as a strategic "viewpoint" fully integrated with the rest of the company, avoiding isolated "ivory towers". Accordingly, respondent 3 analyses the research streams of his company, and describes the story of the R&D department, opened to implement a diversification policy with activities related to nanomaterials and special typologies of glass (in different fields of application, such as textile, ceramics, glass, catalysis, energy, surface coating, biomedical and pharmaceutical). Other entrepreneurs have emphasised the necessity to establish, on a permanent basis, "*technological observatories*" or to aggregate "*micro groups of cross-functional workers*" to rapidly respond to the market requests. In one of the most advanced firm interviewed, there is an innovation culture (on a daily base), highly impactful to face new problems and market challenges, as reported hereafter:
"40 technicians including computer engineers, electronics, mechanics and designers contribute together to the overall vision of innovation. We are dealing with "epidemic technologies" and so working in a multidisciplinary perspective is essential to tackle problems in all their small nuances " (RESPONDENT 1)

c) Innovation as decomposition of complex problem

The ability to innovate not only reduces costs for the company but triggers a reaction in the sub-supply chains, which in turn are heavily influencing the global trajectories with local fallout. These possibilities emerge from a joint analysis (company and research world) of scenarios that start from the company's problems and branch into system challenges (involving all the connected networks), extremely complex to be ruled.

"The study of aluminum (from 1 alloy to 15 alloys) has allowed my company to range between various sectors. The company has become a supplier of manufacturing companies involved in construction and agricultural machinery, milking machines, breeding plants, underwater compressor, biomedical (rehabilitation gymnastics) electric motors, tire changers, pumps" (RESPONDENT 15).

Another clear signal of this new perspective is the role of the sales department, often indicated as an "antenna able to intercept weak signals" for its frequent involvement with clients and suppliers from all over the world and therefore in close contact with new trends before they become such. To prepare for such mental readiness able to capture new opportunities, some entrepreneurs stimulate employees with new challenges, as reported by one interviewed:

"Instead of the usual Christmas basket, I gave my employees a device, equipped with Automatic speech recognition to study how to integrate that technology with the robots we design and build". (RESPONDENT 1).

d) Innovation beyond the boundaries of the firm

Obviously, this dynamism is transmitted by/to clients and suppliers, which are considered as if they were components of the firm, such as "extended arms", thanks to the travels, visits and meeting outside the firm. Then an informal branching system was implicitly assumed operating either during the scouting process of new technologies or in the prototyping phases of a new product/service:

"*An important innovative source of the company comes from my suppliers. They are around 1200 and range from a number of sectors (e.g. metals, crystal, fabrics, plastic, wood, tires, recycling system) and are fundamental to analyse and research new trends*" (RESPONDENT 11).

Monitoring and sensing market have deeply changed, and different roles are emerging even for traditional SMEs. Some suppliers interviewed for this work drawn our attention to their capacity to insert themselves into extremely lively value chains, either through collaborating from scratch with well-known players or their ability to overturn the roles in the provision of materials, machines and services, even orienting the marketing strategy.

e) Innovation as flexibility and digital transition

Respondent 10 underlines how the production process of his firm is very flexible because the high customisation combined with the search for innovative materials (cement, regenerated leather, carbon fiber) cannot guarantee high numbers, but high-quality standards (often the clients are large architecture firms). He defines the company as a "*big joiner's workshop"* that often works on a project basis.

"The company has a network of external suppliers (40 of which are machine tool carpenters), which bring it 2 million in revenue each year. This network allows my company to be flexible and be able to work even on smaller projects" (RESPONDENT 21).

This scenario has pushed even the smaller realities to come out from their comfortable niche where they survived, accepting errors as part of a new broader path, based on the attempt to match craftsmanship with industrial organisation and looking for unexplored techno-productive spaces, where also daring to give hard time to bigger and more structured competitors. Many entrepreneurs have underlined that to reach the abovementioned goal, the digital transformation of productive process, defined "Industry 4.0, is fundamental to support the creative capacity of workers, as reported by an entrepreneur:

"In the last 10 years, in order to remain competitive with time and costs, the automation of some phases of the production process has allowed us to achieve a degree of precision that before was unthinkable and only by integrating our previous knowledge with enabling tools we have been able to rethink processes and products". (RESPONDENT 5).

The emerging entrepreneurial properties

After a detailed reading of all the interviews' notes and all the materials provided by the interviewers, we summarised the findings with the Gioia Methodology (Gioia et al., 2012). We came out with a

table of second-order categories (see table 10), that gave us the possibility to systematise the insights that we have reported in the former part of the results, expanding them according to the voices of the interviewed entrepreneurs (the first order categories)[37] and in relation to the techno-economic scenario presented in the theoretical part.

After a detailed reading of all the interviews and all the materials provided by the interviewers, we summarised the findings (until now narrated in general terms) with the Gioia Methodology, coming out with a table of second-order categories particularly relevant to systematise the insights that we reported in the theoretical part of the work to define the role of entrepreneurs in relation to internal and external environment (see table 10).

Table 10. The second-order categories relative to entrepreneurs as knowledge integrators found with the Gioia methodology.

Categories identified	
Entrepreneurial propensity for new standard and innovative cognitive domains	Strategic coordination capacity of the entrepreneur
Systematic scanning of the knowledge frontier. Risk propensity	Constant monitoring of the external competitive environment. Techno-economic mindset. Finding challenges
Inner dynamic environment. Short and long term decision making horizon of the firm oriented to the medium-long term	Strategic partnerships with suppliers, customers, research centres
Multidisciplinary teams focused on product innovation and project fast learning	Open entrepreneurial mindset oriented to change and crises. Agility to grapple with challenges
Ability to access public resources allocated for innovative projects	Static knowledge-base. Knowledge-gradient focus activity. Exploitation more than exploration activity

Source: Author's elaboration on data retrieved by the interviews' analysis.

5.5. Discussion and the proposition of 4 entrepreneurial typologies

The results confirm that the role of entrepreneurs within the firms and in relation to the "knowledge space" has changed, whereas many economic models still represent an over-simplified

[37] The complete list of first order categories are reported in the annex.

framework in which entrepreneurs are treated as homogenous pieces inserted in an automated system (Teece, 2019). The digital transformation has triggered a pervasive change of the nature of the firm, highlighting the importance to frame companies as open cognitive system, due to the incremental smartness of products and the challenges in the management of information flows. The entrepreneurial function is therefore developing as the management of complex processes and the forecast of unanticipated changes in an economic system that is progressively re-organised by the actions, visions and thought of firms, research centres and institutions.

The aim of this work has been to analyse how entrepreneurs can be used to explain the phenomenon of regional structural change with an explorative purpose, setting the scene for future research on the topic. The centrality of entrepreneurs in the regional economic development has been faced by recent research works, which have acknowledged the Schumpeterian Innovative character (Neffke et al., 2018; Malerba and McKelvey, 2018; Grillitsch and Sotarauta, 2019). This conceptualisation introduces in the debate the "*transformation capability of the innovative entrepreneur"* proposed by Grillitsch (2018), posing the attention on the importance to observe regional economies as the sum of actions, thoughts, strategies and visions of entrepreneurs that they host.

The Hayekian contribute to the distributed and fragmented knowledge together with the Knightian uncertainty are useful coordinates to underline that to discover the economic pattern of a region, professionals, entrepreneurs and people involved in competitive processes are important micro pieces to build a successful strategy (Nooteboom and Stam, 2008). Despite the recent acknowledgement of micro agents as relevant pieces of regional development, the debate between related and unrelated paths of economic development remains open even at a micro-level. To this regard, the concept of relatedness, usually adopted to describe regional structural transformation according to related or unrelated paths (Boschma, 2017), has been recently applied to describe the knowledge integration and creation activity carried out by these entrepreneurial figures, who reproduce the mechanism at a micro level, integrating in single business model local and global trajectories of knowledge production (Bugge and Øiestad, 2015). Accordingly, Fritsch and Kublina (2018) point out the necessity to adopt a micro-lens of analysis to comprehend how entrepreneurs "*identify and absorb knowledge from related and unrelated fields*".

Some researchers have pointed out the importance to link new discoveries to past experiences to find innovative elements, changing something of the previous model and combining it into different ways, namely described as a related branching process (Klepper, 2007; Henriksen et al., 2014).

Other researchers are emphasising the importance to activate micro collaborative networks completely new to entrepreneurs, exploiting new emergent specialisations and therefore trying to

break with the past industrial pattern, namely described as an unrelated strategy of diversification (Vicente et al., 2018). Whatever "choice" between related and unrelated, nowadays, the entrepreneur cannot a-priori exclude the activities of "imagining", "analysing", "deciding" and "initiating" [38] (Gemmell, 2017), because multiple intelligences and their combination are crucial in various phases of the business development: such as design thinking (see the case of Elon Musk[39]), business modelling, start-up and scale-up phases (Gardner, 2011).

Information overload and knowledge exponential growing have so rapidly reduced the natural human time to really experience, making crucial a strategic selection of what to deepen and a capacity to abstract complex things, finding their essential principles with an action of "*transdisciplinary synthesis"*, avoiding traditional division between "*applied and pure knowledge*[40]" (Henrkisen et al., 2015, Lazzeretti, 2019).

Essentially the capacity to imagine and foresight scenarios is an activity that entrepreneurs play in two basic conditions: a) one of "known unknown" and b) one of "unknown unknown" (Teece, 2019). In the first case, it is a matter to use the best strategy according to something that is unknown but that can be framed and then found, searching in the personal toolbox or collaborating with others to solve the problem (Simon and Newell, 1971). In the second case, there is no idea of the consequences of a given action, because the scenario is hardly predictable.

Simon (1973) defines this difference as a matter of well or ill-structured problems. If we consider a well-structured problem a problem for which we can set a strategy to arrive at a set of solutions, an ill-structured problem presents more difficulties to be conceptualised.

This is probably the case for the current techno-economic scenario, where ill-structured problems present more difficulties to be conceptualised (Simon, 1973). To define an ill-structured problem, Simon (1973) uses the example of designing a house. In its micro part the problem could be

[38] Gemmell (2017) studies the learning style of entrepreneurs, framing a model composed by four typologies: *imagining learners*, who use divergent thinking to find solutions to concrete problems and often are attracted by arts and creativity; a*nalysing learners*, who search for theoretical information and try to find theoretical proposition; *deciding learners*, who apply theory to task oriented problems and *initiating learners* that use intuition to solve problems.

[39] *"As The New Yorker magazine noted, "Musk has put forth a plausible idea that doesn't require yet-to-be-developed technologies" (Friend, 2013). The memo and it's 25+ visual sketches, drawings, and figures is, however, the blueprint for something much more impressive than a regional transit line. Instead, the memo presents a promising, innovative, and potentially transformative model that may completely redefine mass transit in the 21st century" (Henriksen et al., 2015, p.4).*

[40] See for instance the description of Gardner (2011, p.4): *"Consider, for example, the twelve-year-old male Puluwat in the Caroline Islands, who has been selected by his elders to learn how to become a master sailor. Under the tutelage of master navigators, he will learn to combine knowledge of sailing, stars, and geography so as to find his way around hundreds of islands".*

represented, thought and so well-structured, but the whole system remains difficult to be defined. This is due because there is not a test to validate if the house responds exactly to a model (n typologies can exist) and, even with a set of conditions, the outcome remains still uncertain. The entrepreneurial models towards which we are evolving are more and more framed as ill-structured problems, within which there is not, speaking in economic terms, a "memory", from which it is possible to retrieve a set of solutions. The problems faced and the solutions proposed by the entrepreneur should be figured out with a continuous exercise of dealing with new unknown challenges.

The gap that we identify in the existent literature is the absence of theoretical models and indicators able to measure this new entrepreneurial function. Many scholars have tried to figure out taxonomies based on sectors, dimension or R&D expenses. Our further effort instead has been to organise the emerging properties that we found in the interviews, elaborating a new theoretical model of entrepreneurship. Foray (2015) states that an effective S3 should include all the firms' typologies, from the "*hungry dwarfs*" (low-tech SMEs) to the "*sleeping giant*" (large firms not innovative) and the "*excited goblins*" (high-tech clusters), arguing that the need for modernisation or diversification is transversal to all the actors of the ecosystem.

As in the examples used by Foray, metaphors and analogies are fundamental to allow mental leaps and to describe some our archetypes, according to the categories identified with interviews and framed in the scenario just described, we took the cue from the Dennett's tower, "a level tower" into which creatures can freely move, improving their performances (Dennett, 1996)[41].

Dennett (1996), is an American philosopher very active in the field of evolutionary biology and cognitive science and uses this tower to describe how organisms act according to their inner qualities and react in relation to external environmental conditions. Dennett (1996) describes 4 creatures: *Darwinian*, able to survive, *Skinnerian*, able to potentiate their existent knowledge, *Popperian*, able to search information in the internal and external environment and *Gregorian*, able to learn how to think[42]. "Climbing" the tower' level towards the last floor allows to observe creatures that progressively increase their capacity to deal with external and internal conditions, setting also "conscious exploration" strategies.

[41] Dennet defines it the "*Tower of Generate-and-Test; as each new floor of the Tower gets constructed, it empowers the organisms at that level to find better and better moves, and find them more efficiently"* (Dennet, 1996, p.373).

[42] Dennett states on that: *"Skinnerian creatures ask themselves, "What do I do next?" and haven't a clue how to answer until they have taken some hard knocks. Popperian creatures make a big advance by asking themselves, "What should I think about next?" before they ask themselves, "What should I do next?" Gregorian creatures take a further big step by learning how to think better about what they should think about next"* (Dennet, 1996, p.378)

Taking the cue from the Dennett Tower, more precisely from Skinnerian, Popperian and Gregorian creatures, it is defined an entrepreneurial ladder by floors, where each floor corresponds to a typology of entrepreneur, defined according to the emerging properties found in the interviews. As in the Dennett tower, the floors are scalable and if entrepreneurs reach the last floor, they will be able to move easily in spaces made by ill-structured problems (the unknown unknown).
The ten categories resulted in section 4 have been attributed to each floor, using a progressive additive criterion. The properties emerged from the interviews considered more basic have been inserted to the first "floor", as the capacity to reinforce the existent knowledge, extracting the maximum benefit. The capacity to have an open entrepreneurial mindset to respond to changes/crisis, the presence of multidisciplinary teams and the capacity to intercept public funds have been inserted in the second floor to describe a firm able to react to external inputs. The presence of strategic partnerships, the possibility to set a medium-term strategy and the monitoring of the technical novelties have been placed to the third floor, in which are present firms able to cope with unexpected. The last floor has been characterised by firms that constantly monitor a wide range of technologies, have a mindset oriented to evolving scenarios and coordinate strategic trajectories apparently distant, foreseeing new trends. From the four floors, we derive the following entrepreneurial typologies (see figure 9):

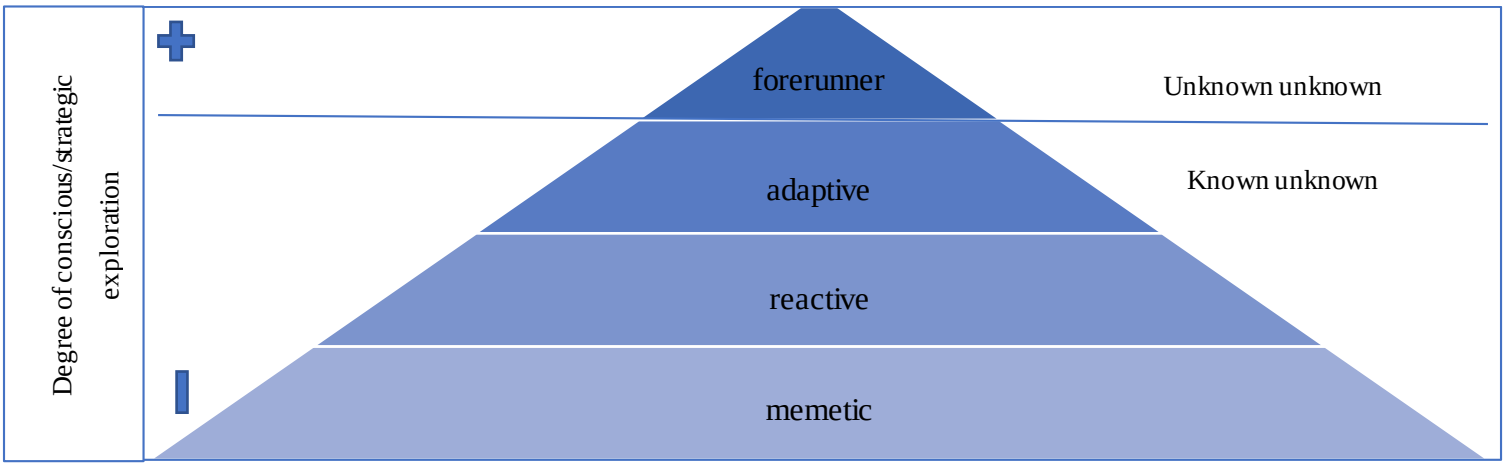
1. Memetic: flexibility and timeliness of response to the layers are the main abilities of this archetype; this figure is able to adopt parameters of solutions proposed by the client and to absorb knowledge guided by the external evolution;

2. Reactive: this figure responds to external inputs, develops sensitivity and is able to react in a creative way;

3. Adaptive: this figure is ready to what happens, even unexpected events; not only receives the input and seeks a "congruency", such as the Reactive, but modifies it in relation to the external environment;

4. Forerunner: this figure anticipates needs, with a strategic propensity and a mind that does not adapt to what finds.

Figure 9. The ladder and the problem space of innovative entrepreneurs



Categories identified			Floor of the ladder
a) Entrepreneurial propensity for new standard and innovative cognitive domains	b) Strategic coordination capacity of the entrepreneur	c) Systematic scanning of the knowledge frontier. Risk propensity	4
d) Constant monitoring of the external competitive environment. Techno-economic mindset. Finding challenges	e) Inner dynamic environment. Short and long term decision making horizon of the firm oriented to the medium-long term	f) Strategic partnerships with suppliers, customers, research centres	3
g) Multidisciplinary teams focused on product innovation and project fast learning	h) Open entrepreneurial mindset oriented to change and crises. Agility to grapple with challenges	i) Ability to access public resources allocated for innovative projects	2
j) Static knowledge-base. Knowledge-gradient focus activity. Exploitation more than exploration activity			1

Source: author's elaboration.

5.6. Conclusions. What are the implications for S3 and EDP?

This paper has analysed the techno-economic scenario where new entrepreneurial styles arise, supporting the theoretical framework with a field analysis of a selected bunch of firms based in Tuscany. Some emerging properties have been identified and finally an entrepreneurial ladder based of four archetypes, namely memetic, reactive, adaptive and forerunner has been proposed.

Among the characteristics emerged across the interviews, the paper stresses how the cognitive capacity of firms assumes a strategic role to re-think fitted business model and innovation policies more adjacent to their real potentialities. The contribution of the paper evidences how incumbents represent new frontiers in the evolution of real industrial system, calling for more detailed analyses on the role of entrepreneurs and their strategies, crucial to understand how value is created (and captured) also at the regional level (Morgan, 1997; Bailey et al., 2019).

The incessant innovative dynamics of the current techno-economic-scenario has exacerbated the need for entrepreneurs to constantly explore fields more and more distant to the original core ("unrelated"), in a continuous tension with the exploitation of the existent capabilities.

In "discovery-driven regimes", such as S3, the process of knowledge integration represents a growing priority for entrepreneurs that can mobilise different resources, spreading them in multiple directions and eventually helping places to preserve their strategic capabilities (Lindholm-Dahlstrand et al., 2018). Given these premises, system-wide cascade consequences can be hypothesised for the structuration of S3 and for the policies related to the conversion of R&D results into economic knowledge.

Many technology transfer policy models were built on a passive conception of absorptive capacity, which does not "*induce any change in the cognitive capacity of the receiver*" (Amesse and Cohendet, 2001). Firms, even SMEs, are nowadays "*processors of knowledge"* and coordinating this amount of complex knowledge represents a hard task to perform for entrepreneurs (Amin and Cohendet, 2004). The entrepreneurs, with an open mindset such as the "forerunner", indicated in this paper, could offer new stimuli for the design of innovation policies, enhancing the system of proposal with a real bottom-up push and not only in spot occasions (such as innovation projects) (McCann and Ortega-Argilés, 2016). In this decentralised model of technology transfer, each firm is not only able to absorb external knowledge (Amesse and Cohendet, 2001), but also to proactively send inputs to the agencies and/or the regional government for developing areas of mutual interest, oriented towards the global macro challenges (e.g. ageing, environment, poverty, social inclusion, etc..), creating new knowledge starting from the analysis of real problems and contexts (this could be the case of "adaptive" and

"reactive" typologies). This perspective could increase the participation even of the "left behind" (laggard) firms (such as the "memetic"), "*without dictating to them the content or direction of their projects*" (Foray, 2018: 830), but offering adequate tools to foster their capacity of building process: new mindsets based on unceasing research and systems thinking.

The consequences of this paradigm are not only for firms, their organisational forms and their boundaries, but impact also the collaboration architecture to which they are connected (Malerba and McKelvey, 2018). For instance, knowledge brokers, R&D centres, universities need to evolve and adapt, being keen on the modularity of products' knowledge bases, considering the huge amounts of scattered information, which influence the way into which innovative products or services are developed and the predatory global competition.

In the current industrial transformation, focused on the shifting towards a new cyber-manufacturing regime of production, Chinese outperformance has influenced a global re-structuration of production systems and trade, creating with an impressive speed strong interdependence with other manufacturing countries (Andreoni et al., 2019; Bianchi and Labory, 2019).

Therefore, understanding the position of firms as elements of local-global knowledge circuits is fundamental to maintain the control over a significant part of competences offered by the job market. A capability building process could start by the ability of firms to demystifying paths to nimbly move across sectors, deconstructing, comparing and criticising technology and their applications and therefore motivating a strategic and routine based readiness (Kirat and Lung, 1999).

Scanning the entrepreneurial potentialities of regions and countries means making available to policymakers a precious information depository of the real situation which could trigger the "exploration journey", without superimposing a distorted image of the future possibilities of territories (Bailey et al., 2019). This activity should start from an oriented and systematic activity of problem solving aimed to increase managerial and technological capabilities of firms, including the paths of discoveries into dynamic policy plans.

6. Conclusions

6.1 The main overall findings and further insights

The choice of a theoretical framework jointly founded on the concepts of relatedness and entrepreneurship has revealed some interesting features to study S3. The first paper has analysed the relationship between the knowledge proximity levels within a territory and its capacity to foster new entrepreneurship with a focus on sectoral specificity. The second paper has investigated the interplay between structures and agency in defining industrial strategy, observing the EDP as a mix of relatedness and institutional entrepreneurship (proactiveness). The third paper has inquired the new role of entrepreneurs in the process of knowledge combination and integration as micro components of a multi-scalar environment.

From the results of the three contributions, it has emerged that relatedness and entrepreneurship can represent a strong theoretical support to S3 if a cross-disciplinary and multilevel interpretation is applied to explain the evolution of territories. The concept of industrial structure is strongly linked to the capabilities of places expressed by the entrepreneurial ability, the presence of cognitive links and competent institutional actors, which represent the absorptive capacity of a system. S3 deals with the opportunity to trigger structural changes, in other words, a transformation (more or less gradual) of the existent capacities to keep up with the socio-technical evolution with a "readiness" to the unexpected. This perspective, which embraces also global knowledge circuits, has been recently acknowledged as a new challenge in regional development studies and as a necessary part of a future agenda aimed to maintain places competitive (Pike et al., 2017). To promote this change, an element of innovation (organisational, managerial, technological, social, psychological, etc..) has to be introduced and the concept of entrepreneurship is exactly the desired flywheel. New firms, to enter the market, should do something that is scarcely present, badly managed or does not exist at all, considering the whole innovation system. The same idea is valid for the entrepreneurs that need new tools, strategies and above all the capacity to coordinate and combine different pieces of knowledge to remain competitive. This is favoured by the institutional will, which, acting in the middle of crucial nexuses, can question the existent status quo in order to increase the innovative potentialities of cities, regions and countries where they are located. To understand this structural change considering the entrepreneurial elements is not enough, because economic transformations are rooted in complex evolving networks in which knowledge (tacit and explicit) flows through job-market and personal relationships. Knowledge is various in nature and modalities of exchange. It is important to overcome the static and dyadic vision of knowledge transfer, pro a dynamic and multilevel vision of networks

that describe proximity flows. The different degrees of proximity between domains of knowledge and the individual capacity to see these connections represent one of the fundamental channels that explain how the novelty elements propagate and create new techno-economic niches.

Describing the discovery idea of structural change promoted by S3 is an arduous task using only a monodisciplinary perspective (the economics' point of view). To fill this gap, the proposed approach has been to study the S3 observing the theoretical axes of relatedness and entrepreneurship as a multilevel image representing a macro relationship as the knowledge spillover dynamics, but also the internal connections of an innovation network and some of the main characters acting in the scene. In the light of the above, this section proposes further insights originated in each of the three paper.

Fist paper

The first paper of the thesis has investigated the effects of sectoral relatedness on the creation of new businesses in Italian provinces, finding novel insights on different patterns according to the type of sector. Accordingly, the crossing area between relatedness and entrepreneurship, used in the analysis, deserve future relevant potentialities, if framed in a multilevel framework. The recurrent creation of new activities is the first step of a path development trajectory towards the critical mass, claimed by Foray as an essential basis to stimulate transformations within the regional economy. The idea of knowledge proximity, represented by the concept of relatedness, is a new key way of mapping possible innovation conduits where new economic transactions happen. Understanding why and how these entrepreneurial patterns arise and develop is one of the most remarkable topics in regional studies. The reasons for these patterns can be logically hypothesised, but actually, remain in the black box. Many elements of the entrepreneurial ecosystem, which contribute to explain this link between the knowledge expressed by a territory and its entrepreneurial capacity to generate new firms, are not directly measurable. However, the results of the paper show that sectoral specificity matters, highlighting the importance to deepen development trajectories of individual industries, avoiding innovation policies "branded" on high-tech labels. Referring to these general findings, S3 presents some issues. First of all, S3 discusses the priorities able to transform the structure of the economy, in particular transversal technological domains (such as the Key Enabling Technologies). These domains naturally expanded beyond the concept of sector, posing serious problems of taxonomy, given also the current statistical classification systems, mostly based on the concept of sector to group different activities (D'Adda et al., 2019). Pavitt (1984), analysing in deep the characteristics of sectors, provided a taxonomy of industrial sectors according to some properties related to the technologies, users and market landscape (namely supplier-dominated, scale intensive, specialised

suppliers, science-based). This classification was very valuable to describe patterns of technological change, but nowadays, in the light of the digital platforms and industry 4.0 paradigm, a new profound re-think is necessary on "what", "why", "how" and "when" has to be measured to get as close as possible to a meaningful representation of the innovation dynamics. The first paper underlined also that not all the dynamics behind the regional branching process can be quantitatively measured, making clear the importance to deepen these topics also with the help of qualitative analyses (McCann and Ortega-Argilés, 2016). However, as stated in the title of a paragraph of a famous paper by Box "*all models are wrong, but some are useful*" (Box, 1979, p.202). As evident, the same concept is valid for the building of meaningful indicators: if well-built they represent a good approximation of real phenomena. The regional governments cannot provide strategic guidance without a set of indicators, able to inform and justify choices. Many regional administrations are struggling with the absence of indicators capable to show the "path creation dynamics" and the real effects of S3 on the real structural change of the economy, beyond the number of innovative projects. Moreover, Gianelle et al (2019) reported how some projects co-financed by EU ERDF are not properly in line with the corresponding S3 at a regional level. This points out the necessity to adequate the instruments to obtain more adherence to the S3 core, as well as the lack of administrative and institutional capacity to cope with the evaluation of complex projects.

The S3 "accounting" criteria seem to represent an obstacle to the S3 improvement, still evaluated with old static instruments, conceived for a "linear vision of innovation" and not to represent "path changes". The scientific community, which is ignoring the philosophical nature of the "metric" and is rushing in the "measurement race", continues to propose unsatisfactory answers to a problem that is not yet well understood, should start from asking a basic question such as: has the S3 succeeded in triggering a structural change in the regional economy? Probably a programming cycle (7 years) is a period of time too short to assess it, but on a longer period, it would be possible to express an opinion on it. For this to be achieved, the starting point could be to urgently tackle the issue of measurement. Some papers have specifically addressed the issue of measurement within S3 (see for instance Colombelli and Quatraro, 2018; Balland et al., 2018; D'Adda et al., 2019), but an integrated and multilevel vision on innovation from micro actors to macro consequences and vice-versa seems to lack. This can be important to measure the degree of "congruence" between the local socio-economic resources and the path of technological change desired, as a complement to the concept of related diversification (Antonelli et al., 2018). This thesis does not provide an answer to this problem, but a future direction of research on S3. Of course, this should be part of a bigger project: researchers alone cannot deal with new metrics, they need the help of institutions and

specialised research centres (as the Joint Research Centre of Sevilla, which has the aim to monitor and drive the study of S3 at the European level) to organise in a different way the databases building process. Many private companies have started to massively collect data to create value and support the decisions' processes with the help of artificial intelligence. In 2013 Michael Bloomberg created the Major's Office of Data Analytics (MODA) to monitor the enormous quantity of data of the New York municipality (Polson and Scott, 2018). A possible direction could be the creation of connected regional offices of data analytics in the style of MODA, but at the European level. This data collection modality could improve the database architecture (harmonising the European system), with continuous analyses based on updated information, extracted from sparse database, at various levels (e.g. from the single firm to the cities' infrastructure). A new data government arrangement is not only an improvement of the current monitoring activities, but it also represents a new data system based on a multilevel exchange of information (NESTA, 2019). A process of data storing structured from the individual to the collective level could reveal hidden patterns and relationship, showing specific resource targeting and intervention relative to the impact of S3 on the regional economy.

Second paper

The second paper of the thesis has analysed the EDP in Tuscany, proposing a mixed interpretative framework based on the principle of relatedness and entrepreneurial agency, in particular looking at the role of institutional entrepreneurs in favouring and creating a shared path with the other regional actors. Results have confirmed the initial theoretical proposition that relatedness is a useful policy instrument if sustained, in a complementary or overlapping manner, by the experiences and the actions, thoughts, visions and plans of the more central actors (in our case the TD, responsible for the helping Tuscany region in developing the strategic roadmaps inserted in the strategy). The paper points out that the micro features of the EDP are not necessarily an automatic expression of the proximity links revealed by the Industry Space of Tuscany, which of course can be asymmetric and have different "hidden" motivations behind their connections. This "sympathetic critique" wants to emphasise that innovation processes are rather complex to manage, being shaped by parallel dimensions and tremendously influenced by the human agency component, which characterises policy representations that otherwise would be only representations of the past (Allen, 2014). This debate on the cognitive dimension of the EDP in balance between a meso map of indicators and an environment defined by the behaviour of micro-agents opens the window on how the problems in innovation policy are framed respect to maps that aim to represent knowledge space dynamics. Mazzucato (2018) defines mission-oriented policies (and S3 can be considered one of them) as complex strategies that should address the major societal challenges in a systemic,

interconnected and multi-perspective way. The real issue is that these challenges are "wicked problems[43]", in other words, neither the knowledge owned is sufficient, nor these problems are easily definable and predictable for their complexity (Wanzenböck et al., 2019). During the industrial age, the goal finding experience was based on a simplistic end-in-view dominated by the idea of efficiency (Rittel and Webber, 1973). In the last decades it has raised the awareness that policy problems are wicked in nature, and one of the major issues faced by policymakers, before the solution's heuristic strategy, has been to define them (in distinction from their "desired image") as part of open systems embedded in entrenched and complex networks (where some of them are inputs/outputs of other problems) (Rittel and Webber, 1973). Respect to a mathematic problem, these kinds of problems are ill-defined and some properties define wickedness such as the impossibility to provide a definite formulation, the absence of a "stopping rule", the absence of a true-false schema, the uniqueness of the problem and the consequential chains (Rittel and Webber, 1973).

Acknowledging the wickedness of problems represent a first important milestone to design EDP and its network of participants, which cannot be predefined ex-ante, but need to be discovered through a learning process of implementation and formulation that depicts the interplay of regional and global actors embedded in a multi-level framework of knowledge and relationships (Lundström and Mäenpää, 2017; Moodysson et al., 2017). Introducing the concept of wickedness allows illustrating the regional policy space not as a well-functioning Fordist factory, where each component has a pre-definite task and space of action, but as a complex ecosystem that can assume endless configurations. The key message emerged by this paper is that to promote systemic logic in innovation policy is necessary to think out of the box to re-shape institutional framework, assuming knowledge exchange and proximity between domains and actors as an evolving picture, made by a continuous interaction between the micro and macro levels of the system. The innovative capacity of Israel is an interesting example of an innovation system where the attributes of people are the active part of the "*technological mashup*" expressed by the spearheads in R&D and firms, which are entrepreneurially oriented to challenges and risks and forced to find creative solutions (Senor and Singer, 2009). Once acknowledged the role of human agency in innovation policy, the real challenge seems to provide an interpretative framework able to diagnose, monitor and find solutions to the

[43] Rittel and Webber (1973) introduced the concept of wicked problem referring to problems that do not have plain and clear-cut planning answers. Nowadays problems like the climate change are classified as super wicked problems because of some key features: *time is running out; the central authority needed to address them is weak or non-existent; those who cause the problem also seek to create a solution; and hyperbolic discounting occurs that pushes responses into the future when immediate actions are required to set in train longer-term policy solutions* (Levin et al., 2007, p.3)

wicked games faced in turn by regional governments (Kuznetsov and Sabel, 2017). The classical example of the man on the moon used to describe the capacity of humans to solve a complex task versus the incapacity to solve a social problem like definitely erase criminality (Simon, 1996). It can be reported as the difference between the resolution of a challenging few-dimensional problems (with a great injection of technological capabilities) and the n-dimensions, variables, actors and feedbacks that make human scenarios in fact unsolvable.

To cope with a fragmented and uncertain context, regional governments can conceive industrial policy as a *"reflection action" and as a (continuous) management of the triple heterogeneity (of projects, strategies, and institutions)* (Kuznetsov and Sabel, 2017, p.70). The right insights provided by S3 advocates are that regions should find priorities on which to invest, obtaining a certain consensus among the regional network. This is not only a more democratised view of innovation, but mainly an opportunity for regions to strategically exploit their hidden potentialities, increasing the amount of intellectual resources devoted to find the best solutions to problems that regional government cannot tackle alone for their wickedness. This is quite more complicated and ambitious than settling the usual horizontal panacea policy aimed to enable the conditions of all the participants to the innovation game. More participants to the EDP means more opinions and a more difficult attempt to achieve the right level of synthesis. This coordination exercise is made even harder due to the continuously changing conditions (external and internal to the region), which calls for an incessant evolution and upgrading of the existent competences by the local institutions.

Simon (1996, p.166) proposes a list of arguments to consider in social planning:

1. Bounded rationality. The meaning of rationality in situations where the complexity of the environment is immensely greater than the computational powers of the adaptive system.

2. Data for planning. Methods of forecasting, the use of prediction and feedback in control.

3. Identifying the client. Professional-client relations, society as the client, the client as player in a game.

4. Organizations in social design. Not only is social design carried out mainly by people working in organizations, but an important goal of the design is to fashion and change social organization in general and individual organizations in particular.

5. Time and space horizons. The discounting of time, defining progress, managing attention.

6. Designing without final goals. Designing for future flexibility, design activity as goal, designing an evolving system.

Some of these points have been (implicitly or explicitly) included in S3 and in the principles design of EDP. Considering them in the light of the wickedness nature of S3 could mean a step towards non-static interventions that identify knowledge flows, which are embedded in interconnected niches

shaped by on-going feedback. In this way innovation can be framed as a more agency-based concept, subject to continuous feedbacks and interactions.

Third paper

The third and last paper of the thesis has analysed transmission mechanisms of knowledge combination and integration at a micro level, reviewing the traditional model of the entrepreneur, mainly based on a local thickening of technical and scientific skills. In the current techno-economic scenario, characterised by multi-technology, multi-functions and multi-domains products and their "digital twins", a new entrepreneurial archetype has emerged with a more explorative mindset oriented to cope with numerous varieties of knowledge types and to take up new global challenges. The entrepreneurial cases discussed in the paper have offered interesting insights at a theoretical level, on the importance to include these "micro-pieces" to scan future opportunities of the whole regional puzzle (Grillitsch and Sotarauta, 2019), and at a practical level, on the possibility to study new policy models more fitted on their real capacities and different abilities. The assumption of a micro-regional-global scheme is crucial to understand how innovation dynamics can develop in the logic discovery proposed by S3 (Kuznetsov and Sabel, 2017). In the last decade, Chinese outperformance has influenced a global re-structuration of production systems and trade, creating, with an impressive speed, strong interdependence with other manufacturing countries (Andreoni et al., 2019). Among the intentions of S3, there is the one to enhance European high quality in traditional manufacturing, matched with new hotly debated themes such as artificial intelligence, robotics, bioengineering, advanced materials, healthcare, green energy, to build new productions capabilities able to set up innovation niches to sit even in the future at the "big table". In this scenario firms, especially the *"first movers"*, cannot be excluded from the analysis (Kuznetsov and Sabel, 2017). Firms represent elements embedded in the local-global knowledge circuits, which coordinates extended supply chains, rule many knowledge "grids" and are able to control a significant part of competences offered by the job market

Mary O'Sullivan pointed out that the gaps of EU respect to other global players were also found in the provision of IT services and goods (Foray and colleagues, 2009). In the last decades, many initiatives across Europe have tackled this issue and, despite a great heterogeneity between European Regions in terms of e-infrastructural endowments, an important concern arises about the lack entrepreneurial capacity of the economy, like a "cultural barrier" (as underlined by Prodi in 2002). This call does not want to emphasise a numerical debate on EU versus US respect to the entrepreneurial rate and/or dimension (giant corporation versus clusters SMEs). It rather focuses on

the "*latent entrepreneurship*" (Prodi, 2002), namely the possibility to have a vibrant entrepreneurial scene settled in a vivid environment, with huge investment in education, the abandon of fear of failure and of suspicious attitudes towards entrepreneurs, together with a clear set of common rules across Europe. In addition, another barrier regarding the innovation capacity of Europe, pointed out by Prodi (2002), is the lack of a common system of patenting and an integrated venture capital market. Notwithstanding almost two decades have passed since the speech of the then President of the European Commission, many of the challenges posed have remained unresolved, but still representing crucial preconditions for the success of innovation policy, such as S3 (McCann and Ortega-Argilés, 2016).

This can be summarised as the "*need to make industrial policy sensitive to the morphology of structural dynamics in each economy or industry"* (Andreoni et al., 2019, p.3). Scanning the entrepreneurial potentialities of regions means making available to policymakers a precious information deposit of the real situation on which start the "exploration journey", without superimposing a distorted image of the future possibilities of territories. Of course, this process of discovery, based on the cognitive space of connections where new relationships can emerge, represents a critical theme beyond the strict logic S3. As underlined by Foray (2015) "Smart Specialisation stories" happened also naturally, without a strategy, as a response of people to technological change (as the introduction of disruptive technologies), to social change (new preferences, new role of customers) and visions of possible future crises. What is relevant to point out for the future framework of S3 and innovation policy in general, is the importance to embrace this new entrepreneurial model, not only as a "reaction to something", but as a normal way to do business in techno-economic landscapes, where a potentially infinite number of combinations is possible. The capacity to acquire capabilities to project and develop products are in some cases transferrable. As a general example, Tuscany firms involved in the production of furniture, smelling a crisis, decided in the eighties to convert their production to the manufacturing of camper, having a set of tools re-applicable to that kind of production. Nowadays, we can hypothesise a scenario where the same firms involved in the production of campers can scan future opportunities of diversification in the yachting and prefabricated construction, with a "rapid shift" thanks to transversal technologies such as advanced materials, geolocation digital instruments and robotics to realise the product and control the production process. This example wants to stress that the current available combinatorial knowledge space can be vastly navigated across the breadth of many disciplines and at various degrees of depth respect to the past (Ozman, 2010). However, in the logic of S3, this could present a controversial issue. Letting firms to freely manage strategic technological domains such as artificial

intelligence, robotics, advanced material, bio-engineering, starting from the analysis of their real problem and business needs, could collide with the necessity of regional government to promote a vertical policy based on few priorities. This is a big dilemma for the future of S3, which can be solved if a widespread consensus arises around an entrepreneurial capability building process (equipped with enough cultural and financial resources), closely entrenched with the existing endowments of regions in terms of research and innovation. Whatever perspective is embraced, the starting point of the analysis to provide sound innovation policy cannot exclude a detailed examination of the entrepreneurial resources with a specific context perspective, especially regarding the SMEs. Accordingly, a real open innovation paradigm should overcome a myopic policy approach only "*producer-centred*", in favour of a modular one, based on the capillary network of potential innovation as suppliers, clients and sub-contractors of leading firms and able to avoid a segmented view of innovation [44] (De Jong and Von Hippel, 2010).

6.2 Limitations of the work

After the summary of the overall findings and policy implications, it is also important to discuss the limitations of the analysis. Many studies that investigate (or that have direct implication on) S3 have used samples based on the majority of European regions, finding evidence of "repeated patterns" for what concerns technological capabilities (Balland et al., 2018;), role of institutions (Rodríguez-Pose et al., 2014), role of entrepreneurship (Content et al., 2019), difference between more developed and lagging regions (Muscio et al., 2015). In this regard, a first limitation of the present work is that it adopts a narrow perspective on Italy with a specific focus on Tuscany and therefore no general evidence can be extracted and considered valid for all Europe. However, this choice is motivated by the necessity to uncover and discuss the theoretical-methodological gap found in analysing innovation dynamics and relative policies of S3. To analyse how these dynamics have taken place, we have started this investigation by the opportunities came out from the econometric estimation results. They have posed further questions that have been developed thanks to "field experiences" with a visiting period at ERDF manage Authority of Tuscany Region and with the direct involvement in a regional project aimed to evaluate the readiness of a sample of firms towards the industry 4.0 paradigm.

[44] De Jong and Von Hippel (2010) describe the cases of Boeing and Sony, respectively producers or airplanes and electronic components, but also users of machine tools to underline how in the same actor could be present two typologies of innovators, producers and users, making difficult adopt clear-cut distinction between innovative actors.

Beyond that, there are also methodological choices that can reveal some limitations. In the first paper, relatedness was calculated using the number of employees in the Italian provinces at a 4-digit level for each included industry as a reference matrix. There exist other methods to measure proximity between sectors or technological domains, as the use of exports (Hidalgo et al., 2007), the use of patents, which uses the co-occurrence of technological classes within the same patent as an indicator of a possible exchange of knowledge (Breschi et al.; 2003), or the use of inter-industry labour flows (Neffke and Henning, 2013). Of course, each of these methods presents some problematic issues, for instance with exports only tradable goods are observable, or using patent some non-formalised innovation dynamics could be missed. The use of inter-industry labour flows or the concept of spinoff (as in Klepper, 2007) can be a more realistic portrait of knowledge "physically" embedded in workers that move from one sector to another. Unfortunately, having access to this kind of data for Italy was not possible and the decision was to turn to employment data, which respect to patent, for instance, have the advantage to include possible knowledge channels that otherwise could remain hidden. However, even the assumption behind the use of employees is not neutral, as it is hypothesised that high concentration of workers (specialisation) in two given sectors in a certain territory implies a possible conduit of knowledge exchange (neither knowing the kind of knowledge, nor the means and modalities of exchange). Notwithstanding, the use of the lower conditional probability formula (as in the Product Space by Hidalgo et al., 2007) reduces the risk to take two sectors that, by chance, can show high proximity values, taking in fact the lower probability value between the two.

Two related issues have been recently raised by Boschma (2017), who stresses the importance to study complementarity and similarity dimensions in the measurement of relatedness, and by Frenken (2017), who points out the non-asymmetry properties of sector's proximity. With the diffusion of Hidalgo methodology, the agnostic ex-post examination of proximity links has come up beside an ex-ante hierarchical classification, opening new windows of analysis. Therefore, the next researches should ask how to include these points as the identification of local-global trajectories of knowledge exchange and integration. As evidenced by Tanner (2014), the use of case studies could open new learning opportunities of what are the mechanisms of knowledge transmission at the micro-level, which in turn could be then tested in more formally built models.

Another possible limitation arises from the operationalisation of the concept of entrepreneurship, used in the first paper. New firms in regional studies are more and more representing intriguing mechanisms to include in models that aim to explain local innovative rate and economic growth. At the same level, the reasons behind the process of new firm formation are central themes still to be explored in the literature of regional studies and a more accurate database could be

built on micro observations aggregated. For instance, the possibility to use LinkedIn as a platform to extract these kinds of data could favour the observation of other determinants of entrepreneurial capabilities of a region, such as labour mobility, typology and level of competences, personal relationships, revealing hidden maps of innovation based on real networks. The call, again, is to furtherly inquire entrepreneurship in regional development as a multidisciplinary concept, not only focusing on the contribution of new entrants, but also adding to the analysis the key role of the existent entrepreneurs in the process of regional innovation (in particular in SMEs). This has been one of the goals of third paper, which, nonetheless, presents some weak points. The purposeful sampling methodology together with the use of Gioia methodology to analyse interviews' data have been employed to explore a theme still in a developmental phase. The properties and the archetype identified should be tested on a broader sampler and in different contexts, in order to achieve a better understanding of the role of entrepreneur as knowledge integrator across many regional paths of development.

For what concerns the second paper, the focus on the EDP of Tuscany, has the limit to look at the process in only one context. The implications on the general structuration process can, therefore, suffer from a context biased perspective, even if each region, according to the S3 guidelines, has the possibility to decide its own strategy to identify the priorities of investment. In addition, the novelty of EDP as the distinctive elements of the explorative dimension of the existent and future potential of territories has required a very detailed analysis of the actors, their vision, decisions and actions. What is desirable for the future is to find a set of comparable elements for the various EDPs, able to evaluate the policy capacity of regions across Europe.

Lastly, the three papers analyse a very specific historical moment, included in the first seven years term of S3 promotion. A larger time span of analysis, given also the relevance of S3 even in the programmatic cycle 2021-2027, could provide to the debate further elements of discussion, which nowadays could be still in the "shadow".

6.3 Future research on Smart Specialisation Strategy: promising streams to be furtherly developed

Future studies on S3 should start from analysing /innovation policy at a local level as a complex and multidisciplinary theme, influenced by many different topics, as briefly mentioned in the introduction of the thesis. This research has generally contributed to this gap filling, notwithstanding

some open windows remain crucial to explore. In this final section, four possible topics are indicated as themes to be further developed to enrich the theoretical and methodological framework of S3: a) Industry 4.0, b) Global Value Chains (GVCs), c) the role of institutions and d) the application of S3 to the so-called lagging regions.

a) Industry 4.0

In the last years, the paradigm Industry 4.0 has revolutionised the foresight of future scenarios regarding the configuration of production systems across the world. The interconnection of productive components within the firm and along the supply chain together with the simultaneous use (and development) of advanced technologies has caused new challenges relative to firms' business models and value creation (European Parliament, 2016). Cyber-physical systems allow increasing flexibility, mass-customisation, interaction between designers, suppliers, producers and clients, reducing the response time and increasing the quality (European Parliament, 2015). This paradigm shift needs to be rapidly tackled by firms: more and more digital infrastructure will represent a *"conditio sine qua non"* for business creation and development. Much information on production processes, commercial exchanges and feedback ,previously ignored, have become available thanks to the algorithmic evolution (e.g. the centrality of cloud) combined with an extraordinary computational power of modern tools (Kenney and Zysman, 2016). Therefore, this very high connected space of information, processes and ideas has raised the probability of discovering completely new products and creating new businesses with astonishing velocity, acting as the main enabling element within economic systems (Carlsson, 2004). The implications are not only in the engineering of processes, but also for the identification of strategic competences that will be crucial to do and/or start from scratch a new business and manage projects in this entirely new environment (re-skilling and up-skilling) (Bailey and De Propris, 2019). Analyses and researches on S3 should consider the impact of Industry 4.0 on the European manufacturing system and on the entrepreneurial style. The call is for inserting S3 in an integrated vision with the Industry 4.0 paradigm, looking at the lessons that can be learned, especially in the design of EDP and in the identification of priorities, whatever they might be (Cifolilli and Muscio, 2018).

b) Global Value Chains (GVCs)

Products, before to be commercialised, cross many borders (regional and national) and sometimes the intermediate processes with more value added are not perceived by the final

consumers. The coming of Industry 4.0 paradigm is making the GVCs integration process no more representable as a linear chain of instruction from producers to consumers, passing through suppliers and distributors, but more like an open information exchange with loop and feedback mechanisms (World Bank, 2019). Accordingly, the wide possibility of regions to choose priorities among a set of related and unrelated domains of knowledge makes impossible to ignore the integration of local and non-local pipelines of production (Asheim, 2019). GVCs are nowadays naturally embedded in many regional economies, which are more and more interconnected with key global players (such as MNEs), which are able to heavily influence the structuration of resources and competences present in the local actors (Bailey et al., 2019). Thus, S3 cannot ignore the global embeddedness of local development strategies. Moreover, studies on S3 should map the potential linkages in terms of actors, skills and infrastructures, between territorial paths of transformation and global evolving value chains, helping policymakers (initially with pilot examples) to design policies open to the world, but able to capture a value for the territory (Brennan and Rakhmatullin, 2015; McCann and Ortega-Argilés, 2015; Radosevic, 2017).

c) The role of institutions

In the last decade, the role of institutions has been explicitly addressed as one of the prominent topics to explain regional development and on what reflect to build sound policies (Rodríguez-Pose, 2013). Institutions represent the prerequisite to promote innovation programmes and above all the learning capacity of a region (Morgan, 1997). The formal ones serve to guarantee the respect of rules and the informal ones to create trust and collaboration (Morgan, 2016). A consensus has emerged between scholars that examine the role of institutions on regional development concerning the crucial importance to have solid and proactive governments and harmony between social spheres to create collective entrepreneurial experiences, necessary to build a shared vision (as the case of Basque country explained by Morgan) (Kroll, 2015; Morgan, 2016; Sotarauta, 2018). Even if a growing number of authors is analysing the role of institutions within S3, furtherly investigations are needed to understand how the capacity building process of institutions works. How governments learn and evolve? What are the technical and social skills necessary to enforce the innovation strategy at the local level? What are the emerging alternative institutions (such as start-ups incubators, regional agencies of development, technology transfer centres)? This is inside the core essence of EDP, which otherwise can be reduced to a mere technical mechanism, ignoring the politics, the power, the relationships behind the settlement of a shared regional agenda as an experimental joint agreement (Sotarauta, 2018). This latter point on EDP could lead to further questions related to its feasibility and success and to its underpinning mechanisms such as the evolution of the actors' dialogue and

social relationship in terms of conflicts, attitude, mentality, misalignment of interests and their real involvement in the process (Brenner, 2019).

d) The lagging regions

Europe finances less developed regions with a bigger quota of ERDF, which, nonetheless remain less able to produce innovative outputs in comparison to the more advanced ones. This mechanism seems to reward only the regions that "stand on their own feet", neglecting the difficulties of backward regions. Capello and Kroll (2016) emphasised some missing socio-economic conditions which affect the development capacity of weaker territories for a number of reasons, well described by McCann and Ortega-Argilés, (2015, p.1294):

"*sectoral, structural, transactional, technological, behavioural, related to resources and capabilities, related to risk and financial flows, related to externalities and issues of market failure, and also related to commercial and cultural perceptions"*.

This scenario makes hard in some contexts to adopt and implement innovative strategies of development, such as S3. Citizens of backward regions have embraced this feeling, expressing their political votes against Europe, represented by a clear "geographical map of discontent" (Rodríguez-Pose, 2018). This dangerous condition of division and inequality could lead to future political turmoil. Foundational Economy, in line with the capabilities approach a là Sen, is a promising theoretical framework to study the basic set of goods and services to have a decent life and represents a possible milestone on which innovation preconditions can be built (Morgan, 2019). Future studies that analyse S3 should examine the preconditions that generate innovation in lagging regions, understanding the successful cases and the failures (Trippl et al., 2019). This specific area of research is strategic for the future structuration of S3 across European Regions and future findings could help to understand if S3 is really a policy applicable to lagging regions (as recently stressed by Foray[45]) or not and what eventually are the initiatives more fitted.

[45] Foray (2019) in response to six critical questions about S3 by Hassink and Gong (2019) underlines that thanks to the S3 experience of the last years, it seems more evident that S3 has a lower potentiality in lagging regions.

7. References

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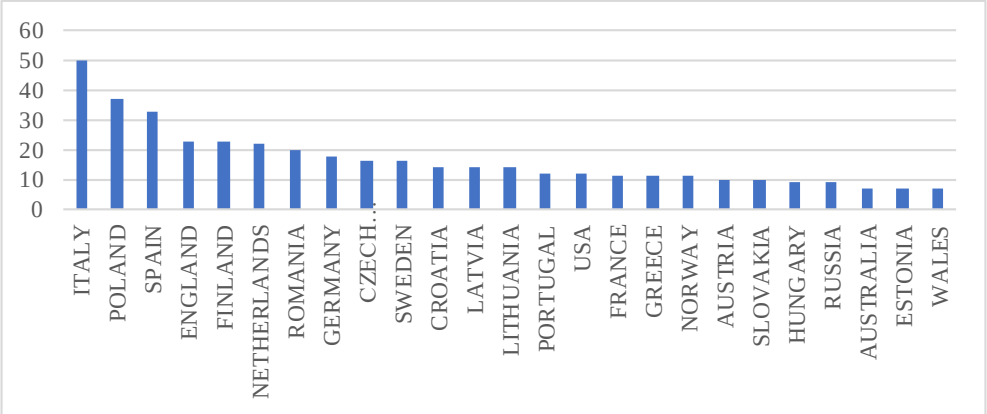
ANNEX

INTRODUCTION

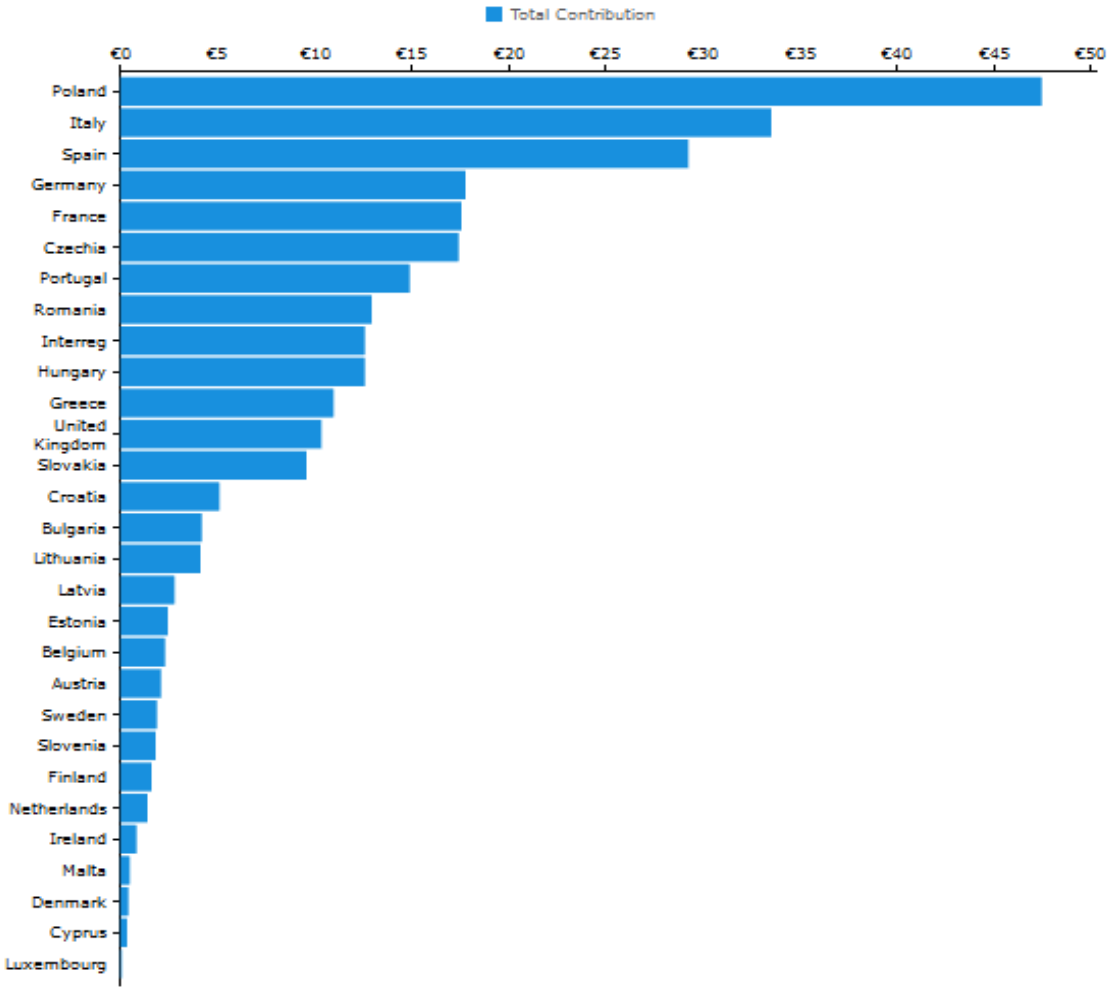
Figure 10. Number of scientific contributions by country[46] from ISI WOS database for the query "Smart Specialisation" until August 2019



Source: Author's elaboration on ISI WOS

[46] The number of total contributions exceeds the value of 361 (the number of publications at the date of data extraction – 29 August 2019), because some researchers of different countries have co-authered some papers.

Figure 11. European Regional Development Fund (ERDF), total budget by Country



Source: Cohesion Data portal, 2019.

Table 11. List of "Knowledge for Growth" group[47]

• Chair: Commissioner Janez Potočnik •Vice-Chair: Dominique Foray (French), Professor of Economics at École Polytechnique Fédérale de Lausanne, Dean of the College of Management at EPFL (CH). •Bart van Ark (Dutch), Professor of Economic Development, Technological Change and Growth at the University of Groningen (NL) (Vice-Chair of the Group 'Knowledge for Growth' 2005/2006). Executive Director of Economic Research at The Conference Board (US). •Maria Carvalho (Portugese), European Commission, Bureau of European Policy Advisers. Former Portuguese Minister of Science and Higher Education. •Paul A. David (American), Professor of Economics at Stanford University (US), Professeur Titulaire of Innovation and Regulation in the Digital Economy at Ecole Polytechnique and Telecom Paris Tech (FR) and Professorial Fellow of UNU-MERIT (NL). •Jean-Paul Fitoussi (French), Professor of Economics at the Institut d'Études Politiques de Paris, President of the Scientific Council of the Institut d'Études Politiques de Paris (FR). •Anastasios Giannitsis (Greek), Professor of Economics at the University of Athens (GR). Former Greek Minister of Foreign Affairs and Minister of Labour and Social Security. •Marianne Kager (Austrian), Chief Economist of Bank Austria Creditanstalt (AT). •Bronwyn H. Hall (American), Professor at the University of California at Berkeley (US) and Professor of Economics of Technology and Innovation at the University of Maastricht (NL). •Georg Licht (German), Director of the 'Industrial Economics and International Management' department at the Centre for European Economic Research (ZEW), Mannheim (DE). •Jacques Mairesse (French), Inspecteur Général at the 'Institut National de la Statistique et des Études Économiques' (INSEE) and senior researcher at CREST and at GRECSTA (FR). •Ramon Marimon (Spanish), Director and Professor at the European University Institute in Florence (IT) and Professor at the Department of Economics and Business of Universitat Pompeu Fabra, Barcelona (ES). Former Spanish Secretary of State of Science and Technology. •Stan Metcalfe (British), Professor of Political Economy and Executive Director of the ESRC Centre for Research on Innovation and Competition at the University of Manchester (UK). •Mojmir Mrak (Slovenian), Professor of Economics at the University of Ljubljana (SI). •Mary O'Sullivan (Irish), Professor of Economics at Wharton Business School (US). •André Sapir (Belgian), Professor of International Economics and European Integration at the Université Libre de Bruxelles (BE). •Reinhilde Veugelers (Belgian), Professor of Economics at the University of Leuven (BE),fellow of the think tank Bruegel, Brussels, and a former member of the Bureau of European Policy Advisers at the European Commission.

Source: (Foray et al., 2009)

[47] For a general panoramic on K4G activities see:

https://ec.europa.eu/invest-in-research/monitoring/knowledge_en.htm

CHAPTER THREE

Internal and External Relatedness: formulas

Hereinafter are represented the two general formulas for external and internal relatedness:

$$Relatedness_{paExternal} = \sum_{a=1}^{A} R_{awp}\left(\frac{n_{ap} + n_{wp}}{N_p}\right)$$

$$Relatedness_{paInternal} = \sum_{a=1}^{A} R_{aa_np}\left(\frac{n_{ap} + n_{a_np}}{N_{Ap}}\right)$$

In the external relatedness formula p represents the province, R_{awp} is the index of relatedness between the sector *"a"* and the other sectors w (external to A) in a given province p, n_{ap} indicates the number of employees in the sector a of the province p, while n_{wp} is the number of the employees of the sectors external to the macro sector A for the same province. N_p represents the total number of workers of the considered province.

In the internal relatedness formula R_{aa_np} is the is the index of relatedness between the internal components of the sector *"a"* in a given province p, while N_{Ap} represents the total number of workers of the considered province.

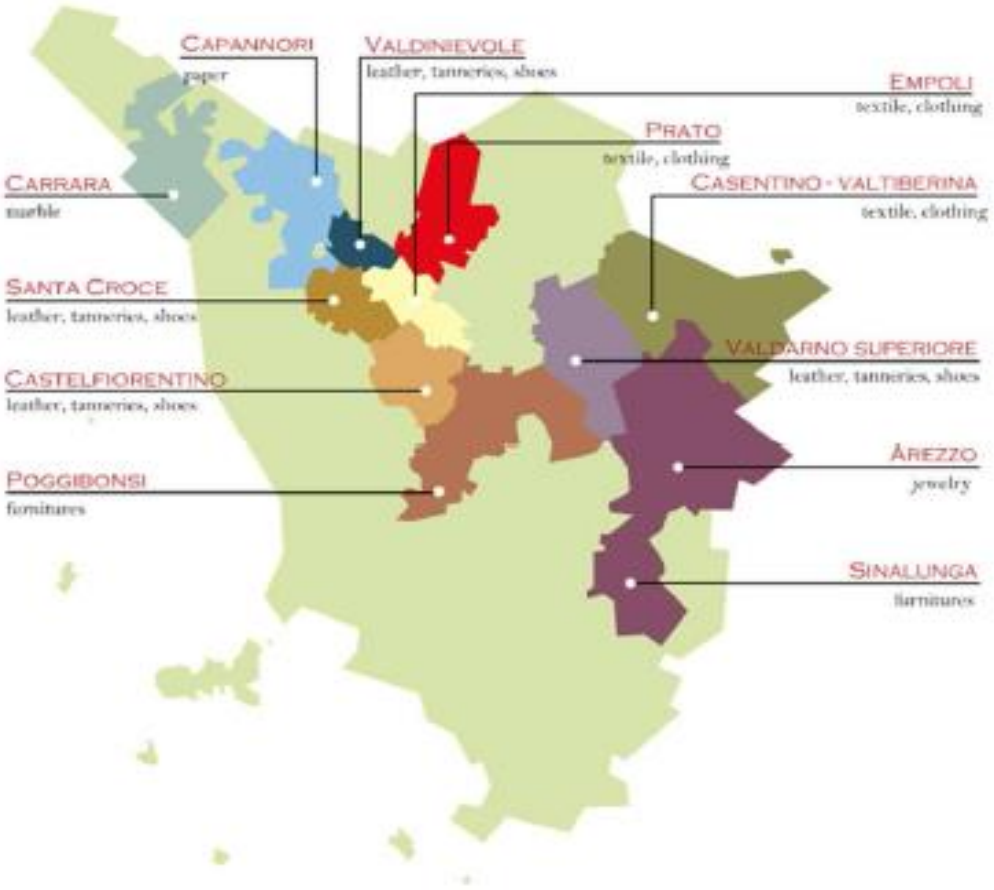
These indicators allow to have a value of provincial relatedness among the sectors of interest and all the other sectors (external to macro sector A for external relatedness and internal to macro sector A for internal relatedness) weighted for the reciprocal concentration of employees (for a similar computation see Innocenti and Lazzeretti, 2019b).

CHAPTER FOUR

Table 12. Summary of data on the interviews to the Technological District

Technological District	Date of the interview and modality	Duration	Location of the District	Website
District for Rail Technologies, High Speed, Safety and Security (DITECFER)	17/01/2019 (face to face)	1h and 20 minutes	Pistoia	http://www.ditecfer.eu/
Nautical and Port Facilities (DIPORTO)	17/01/2019 (face to face)	54 minutes	Viareggio	https://www.navigotoscana.it/
Interiors and Design (DID)	24/01/2019 (face to face)	1h and 41 minutes	Poggibonsi (Siena)	https://www.distrettointerniedesign.it/
Advanced materials MATE	24/01/2019 (face to face)	59 minutes	Empoli (Firenze)	http://www.distrettomateriali.it/
Lifescience	25/01/2019 (via Skype call)	1 h and 16 minutes	Siena	http://www.scienzedellavita.it/
Energy and Green Economy (DTE2V)	25/01/2019 (face to face)	1h and 7 minutes	Firenze	http://dte-toscana.it/
Tuscany Fashion Cluster (OTIR)	8/02/2019 (face to face)	58 minutes	Prato	http://www.otir2020.it/
Marble and Ornamental Stones	Online exchange of information		Carrara (Massa-Carrara)	http://www.distrettodelmarmo.it/

Figure 12. Map of the economic specialisations of Tuscany



Source: Tuscany Region, 2012

FIFTH CHAPTER

Table 13. The Gioia Analysis first-order concept[48]

Concepts and ideas of the interlocutors	Category identified
"After the company where I worked went into liquidation, I started to do sell colour televisions and in the meantime, I began to study self-taught software". (RESPONDENT 1) At the age of 17, Mr. 5 worked in a goldsmith company he was able to develop his passion for mechanics. He was framed as a workman but he was also involved in the design. After that experience, he decided, driven also by the desire to overcome the mental barriers of his local context ("you are already a worker!"), to enroll as a student in the mechanical high school and in 4 years he took the diploma of mechanical expert. (RESPONDENT 5) In 2008 a meeting with an electronic engineer, change the firm mentality. The engineer, after being "evangelized" on the warp, applied his computer skills in a different sector, with very important consequences for the company. With his presence, the company created advanced warehouse management programs and started a digitalisation process, involving machines modernisation and workers training on how to manage this new tool. (RESPONDENT 6) Mr. 7 managed to do a "non-traditional" course of study: *"oriented by the problems I found on workdays, in the evening I went to the nearby library and, driven by the engine of curiosity, I tried to figure out by myself the mechanism of research. I applied the findings in the morning. And this pattern has repeated until the coming of web search tool"*. (RESPONDENT 7) Mr. 7 is very passionate about Leonardo Da Vinci and from him draws inspiration to approach culture as a global and systemic one, arguing that the key to innovate is to rethink processes based on hidden needs and signals, allowing ourselves the opportunity to make mistakes. (RESPONDENT 7) Mr. 12 claims to have a curiosity about the world of innovation, and this open-mindedness has been very useful to "*see beyond the limits"*, in comparison to the specific expertise of his technicians. This vision	Entrepreneurial propensity for new standard and innovative cognitive domains

[48] The table presented 61 extracts from the interviews to let the reader understand how the categories have been defined. The person involved have been reported with pseudonym according to the number of the interview (e.g. "Mr.1" is due to Interview number 1).

was crucial for the evolution of the company (e.g. the introduction of augmented reality to help clients to imagine how to design living spaces). (RESPONDENT 12). The company is oriented towards the industrial sectors that want to deal with. Recently the firm, specialised in the production of sandwich panels, bought a chassis to conduct experiments for Azimut, Tuscan leader in Yacht production and apparently distant from their core activity (RESPONDENT 23)	
Mr. 3 leads the meeting with commercial, patents and funding and R&D departments, defining guidelines "technology oriented" to realise products with high value-added (as the photocatalytic purifying filters) (RESPONDENT 3) Mr. 4 narrates three phases that have conducted to the actual structure of the company: a) company built on his shoulder and oriented to profits; b) focus on high quality and delivery times; c) moving from a craft company to an industrial one, with "*modular attacks on various parts of the system*", in which he was important to capture weak signals, but the structure functions on its own. (RESPONDENT 4) Mr. 5 defines himself as a "*transversal coordinator of multidisciplinary skills*" of products more and more complex that require the combination of many skills (in his case a role that has intensified in the last 10 years). (RESPONDENT 5) Mr 7 argues that the entrepreneur as a strategic coordinator of different knowledge inputs is crucial, but it does not replace the fundamental role of the team. Accordingly, Mr. 7 underline that in 1500 the whole knowledge could physically be enclosed in a room, nowadays its exponential increase causes that not all knowledge can be possessed by a single human being. Consequently, the products are multidisciplinary and no sector/discipline is excluded a-priori. (RESPONDENT 7) The role of Mr. 13 within the company is of a management nature and thanks to his strong technological culture (degree in mechanical engineering, an unfinished Ph.D. in mechanical engineering and honorary degree in thermal-hydraulic engineering), he coordinates the realisation of systems and services for the cold chain and for temperature control, in the bio-medical sector, scientific research and industry. (complex products which integrate different disciplines such as thermodynamics, advanced materials, electronics and software) (RESPONDENT 13) The competitive environment is varied and the ability to respond quickly plays a crucial role. "*It requires a great effort offering good*	Strategic coordination capacity of the entrepreneur

products and services to 700 customers, of whom 300 on a yearly base". (RESPONDENT 21)	
There are monthly strategic coordination meetings between Mr. 1 and the managers of each division with the aim to think about possible improvements to be made and by executing market-oriented forecasts on new technologies and their possible applications, in order to anticipate the competitors. (RESPONDENT 1) This operational framework is possible because in the firm ideas and projects are developed independently, functional for all company divisions, within a "Laboratory of Ideas". (RESPONDENT 1) The technical-productive frontier is not only analysed by the R&D division but also by the commercial side: a technological observatory has been established where meetings are held weekly to exchange information. (RESPONDENT 3) The company has set up a job team dedicated to R&D (chaired by Mr. 13), which operates on the verification of performance, energy consumption, eco-compatibility. It has particular attention to the latest technologies, concerning the prospects for refrigerants and energy regulations. (RESPONDENT 13) The company is a founding member of an Italian technological consortium, which often participates in national and international trade fairs and events, concerning mechanics and all related sectors (such as the Hannover fair). In addition, the company is member of the advanced manufacturing 4.0 technology district. These networks contribute to the enhancement of their flexibility (as a small reality) to face market challenges with a certain critical mass. (RESPONDENT 15) New technologies are monitored daily. The company carries out many R&D initiatives, into which there are not only new products but also products with new concepts (with a digital component), taking into account that in 10 years 70% of its customers will be millennials. This digital transformation, also given the size of the group, will be slow and for this, the owner recently hired an electronics engineer who is studying how to integrate the digital component into their traditional products. (RESPONDENT 18) Mr. 24 is an observer of the world and uses technological innovation to attack the markets. He has recently hired an electronics engineer only to monitor the latest trends and to conduct research through a simulation software (RESPONDENT 24)	Systematic scanning of the knowledge frontier. Risk propensity

The strategy of the company is that of the "hare": they look behind at the competitors to see if the gap with them is augmenting or reducing. If the gap is reduced, the possibilities are essentially two: "*am I wrong? Are they doing better on something?"* (RESPONDENT 4) The firm frequently goes at specialised fairs to control what the others do (RESPONDENT 9) The long-term strategy is based on the analysis of markets and trends. The research is done by Mr 10 himself, who participates in trade fairs and travels with high frequency (ca 90 flights per year). He wants to see the last fashion local, the last trendy restaurant, to find inspiration to bring back to the company innovative elements. (RESPONDENT 10) *"The study of aluminum (from 1 alloy to 15 alloys) has allowed my company to range between various sectors. The company has become a supplier of manufacturing companies involved in construction and agricultural machinery, milking machines, breeding plants, underwater compressor, biomedical (rehabilitation gymnastics) electric motors, tire changers, pumps".* (RESPONDENT 15) The company draws information from a large commercial structure (7 people dedicated to the foreign market, 3 area managers and 100 retailer companies), which constantly updates the property with an overdose of information. (Mr. 19's task is to understand what information is relevant). Furthermore, participation in events is important to understand market directions and to study competitors in the marketing field. (RESPONDENT 19) The company continuously innovates: after having created a stable structure, they started to propose themselves no longer as "passive contractors", offering assembly activities and then moving from simple sheet metal suppliers to a finished product (from cutting, folding, painting, carpentry up to assembly). "*We basically oriented the market in sandblasting and bending activities"*. (RESPONDENT 21) "*Every week we have a meeting for commercial and operative challenges. Recently we seize the opportunity of an international call for tenders related to supply commercial vehicles to the municipality of Paris and we defeat competitors such as Nissan*" (RESPONDENT 22)	Constant monitoring of the external competitive environment. Techno-economic mindset. Finding challenges
A significant fact in this regard occurred at the end of the nineties, when the R&D department strategically opened to implement this policy of diversification with activities related to different fields of research on nanomaterials and special glasses. The research center is involved in more than 15 projects in different fields of application;	Inner dynamic environment. Short and long term decision making horizon of the firm

textile, ceramics, glass, catalysis, energy, surface coating, biomedical and pharmaceutical. (RESPONDENT 3) The firm has 5-10 transversal projects managed by a team leader, which transmits knowledge on various levels (internal and external) (RESPONDENT 9) In 2010 the European Union introduced the obligation to use specific bio-medical devices certified for the transport of blood. This news, thanks to the company know-how has opened a window of fundamental opportunity, which Mr.13 has been able to grasp, pushing for the realization of highly customizable products in this branch. (RESPONDENT 13) R&D is very important for business development. In 2018, approximately 8% of turnover was spent. The R&D activity consists of two phases: a) continuous improvement on the machines (in terms of sensors to monitor the level and type of the liquid for the machines that produce bottles); b) realization of prototype machines through pre-engineering studies (RESPONDENT 14) Before the R&D department was isolated from the rest. Now it is included in every technical office and in each factory there is a team of specialized designers. This modus operandi derives from the fact that the customer chooses the supplier not the product: the ability of the firm is to satisfy any requests for post-sales support (RESPONDENT 18) *"Innovating in the wine production sector is complex because the seasonal trend influences every type of planning*." Therefore, right investments are fundamental (e.g.the choice of blend and markets) because "*establishing a new successful wine production takes a long time (from 8-12 years), while trends change about every 2-3 years".* The trial component must, therefore, be included in a long-term project, considering the structural loss at the agricultural level. (RESPONDENT 19)	oriented to the medium-long term
Strategic collaborations are with companies of about 4-5 employees on average with a win-win logic: micro-enterprises cannot easily access the market, but possess an important technical know-how (RESPONDENT 5) Researches with the luxury brands are conducted to innovate the prototyping phase (process innovation) (RESPONDENT 8) The firm is in contact with an important automotive brand, from which they had the opportunity to visit the research center and the factories, (RESPONDENT 9)	Strategic partnerships with suppliers, customers, research centres

"*An important innovative source of the company comes from my suppliers. They are around 1200 and range from a number of sectors (e.g. metals, crystal, fabrics, plastic, wood, tires, recycling system) and are fundamental to analyse and research new trends*". (RESPONDENT 11) Since 2011 the company has started to make the most important products with strategic partnerships (universities -faculties of automation and robotics and Industrial Thermodynamic Engineering- and private companies), whereas before everything was done internally. Furthermore, partnerships are also developed with end-users (mainly hospitals), who with their (digital) feedback make a contribution in terms of design. (RESPONDENT 13) The growth of the firm took place through new "manufacture oriented" products, from their capillary logistics network of retailers, from the continuous search for new partnerships, from the transition from producing locally and selling global to producing global and selling local (where it is produced). (RESPONDENT 18) *"The company has a network of external suppliers (40 of which are machine tool carpenters), which bring it 2 million in revenue each year. This network allows my company to be flexible and be able to work even on smaller projects"* (RESPONDENT 21)	
The organization of work is based on 80 micro workgroups and the company's goal is to have all employees involved in the improvement of the company. The workgroups are defined by Mr. 4 as "cross-functional" between the various production areas. (RESPONDENT 4) For specific necessity (as for the realisation of particular products) interdisciplinary workgroups are created and relative meetings are held with managers and other key figures (even external to the firm) to set the strategy (RESPONDENT 8) Their production is very flexible because the high customization combined with the search for innovative materials (cement, regenerated leather, carbon fiber) does not guarantee high numbers, but high quality (often the clients are large architectural firms). They define themselves as a "*big joiner's workshop"* that often works on a project basis. (RESPONDENT 10)	Multidisciplinary teams focused on product innovation and project fast learning

The study of new products is faced by a working group composed of various profiles to validate the technical part, the design and the possible reaction of the market (RESPONDENT 11) When the company participate in fairs (like the one in Hannover, but also in Zaragoza, Paris) includes all workers (15 in total) for team building days and to understand the challenges of the market and how these also affect productive work from a multidisciplinary point of view (RESPONDENT 15) Until 2016 the firm was oriented to a standard way of production. Then the firm started to do a lot of product innovation with the involvement of multidisciplinary teams, using different materials and different formats, taking a great interest also in Industry 4.0. According to Mr. 20, his firm is changing the way of making panels and the connected service offer. (RESPONDENT 20)	
At the end of the eighties, Mr. 2 took the exclusive from a firm to make lycra (having also the territorial monopoly of machines in the range of 100km). The development was exponential without competition, even if in 2001 a crisis began because the textile machinery industry invented a new technology and their special machines became obsolete. In 2010 the firm made an elastic yarn with the characteristics of a normal soft yarn and in 2012, thanks to the patenting of stretch yarns made with pure linen, hemp and ramie, the firm was able to recover from the crisis. (RESPONDENT 2) In 2011 the firm was awarded with a local prize for the courageous choices to invest in cutting-edge machinery in times of crisis. (RESPONDENT 6) *"Our firm was able to convert its production from furniture to camper production"* (RESPONDENT 9) Until 2010-2012 the reference market was 70% cosmetic and 30% pharmaceutical. Now 80/90% has become pharmaceutical. The change in question was dictated by the vision of Mr. 14, who understood that the pharmaceutical sector allowed to produce products with a higher added value (stringent standards, special materials), then in the cosmetic segment, more focused on cost reduction. (RESPONDENT 14) Until 2004, the company worked in the sugar sector in a monopoly regime throughout Italy. At the beginning of the 2000s, the then European Community set a strict regulation for the production of sugar, with a stable supply of European funds and many companies closed. The firm has had to reinvent itself producing horizontal and vertical panel saw	Open entrepreneurial mindset oriented to change and crises. Agility to grapple with challenges

And vertical machining centres, with particular attention to the search for new composite materials. (RESPONDENT 16) The company was founded as a woodworking, but over time it was perceived the opportunity to shift to a more technological production and polyurethane insulating sandwich panels were started to be produced. (RESPONDENT 20)	
The company presented a project funded by European Regional Development Funds 2014-2020 to support their internationalisation strategy in the countries where its patent has validity (RESPONDENT 2) In relation to the European and regional public funds, the firm' s vision was to establish a "project path" (20 European projects for more than 30 € million) (RESPONDENT 3) The firm has an in-house R&D department with 9 people who spend their time searching for increasingly sustainable treatments (such as the PVD-Physical Vapor Deposition for galvanic) and "just" documenting what they do, ask for regional funding. (RESPONDENT 4) The company presented a project funded by European Regional Development Funds 2014-2020 related to domotics, which exploits, thanks to a web-based platform, innovative low power solution able to connect the various objects using only existing energy conductors to power appliances and lights (RESPONDENT 10) Using European Regional Development Funds, the firm patented a productive process with a high degree of automatisation using innovative materials (such as the amorphous steel), creating a process similar to that of warping and skein of the textile sector. (RESPONDENT 24)	Ability to access public resources allocated for innovative projects
"*The firm is very keen on process innovation to save energy cost and time".* (RESPONDENT 11) *"The clients want certificates more than* *Solid machines.* *We are investing in machines equipped with electronic components, that are more controllable by certification bodies and that have a higher market value".* (RESPONDENT 14)	Tendency to strengthen existent knowledge-base. Exploitation more than exploration activity

The R&D department of the firm constantly looks for the implementation of existent products, in the attempt to improve the durability and reliability of its product. (RESPONDENT 16) The production of the firm has developed combining its expertise on craftsmanship with new technologies and in the choice of best materials - metal, wood, leather, fabrics capable of combining in terms of design and quality. (RESPONDENT 17)	

Source: Author's elaboration