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"Regional learning networks in medium tech sectors and European integration"

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1. Introduction

In recent years, it has become increasingly recognised that knowledge and innovation are primary factors of economic growth. At the same time, it has been also acknowledged that production and innovation have a fundamental spatial dimension. Concepts like clusters, industrial districts, etc., have become in the last two decades a major focus of attention for social scientists and policy makers. The convergence of these two streams of literature has – not surprisingly – led to the idea that knowledge and learning are powerful factors of agglomeration.

In this paper, we try to summarize and discuss some of the main linkages between the concept of agglomeration economies on the one hand the cognitive processes, by emphasizing the cognitive micro-foundations of the former and the territorial dimension of the latter. In particular, we focus attention on processes of knowledge integration and of interactive learning between firms which occur in clusters specialized in medium technology sectors, rather than in high-tech industries, which have been more extensively studied in the literature.

The joint share of medium-high and medium low technology sectors represents more than half of the OECD trade (53,5%) and this share has been basically stable in the 1994-2003 period. On the contrary, high technology sectors (24,8%) indicate an increase which compensates the decrease of the low technology sectors (20,7%), without affecting the relative importance of medium technology sectors (OECD, STAN Indicators Database, March 2005).

This trends may be explained by the important changes occurred in the world trade during the last decade, as the most dynamic countries have been those which still have a lower development level with respect to OECD countries and which mainly export and also import productions, which are classified as low technology sectors.

Within the EU-25 in 2004, services accounted for approximately two thirds (66.9%) of total employment. The manufacturing sector was only responsible for 18.7% of total employment. In other terms, almost 130 million persons were employed in services whereas only 36 million were employed in the manufacturing sector (Felix 2006).

Employment in the total manufacturing sector between 1999 and 2004 decreased at an annual average growth rate (AAGR) of 1.2% at the level of the EU-15. However, Estonia, Greece, Spain, Italy and Slovakia increased or remained stable during this period.

Moreover, in the European Union, employment in manufacturing is especially concentrated in low and medium low tech sectors (23.022 thousands). Medium-high tech sectors (11.023 thousands) have a lower importance, but they are also much more important than high tech sectors (2.218 thousands). Medium high tech industry is especially important in Germany, Italy, UK and France. But also low and medium low industry is particularly important in Germany, Italy, France, Spain, UK and Poland.

Similar results are indicated by value added statistics as the value added of manufacturing industry (1 533 907 millions) is to a large extend made by low and medium low tech manufacturing, as high tech industry represents only a small share (195 521 millions), which is smaller than medium high industry (476 155 millions).

These statistics indicate the importance of medium tech sectors in export, value added and employment and underline the need to design an approach to European innovation policy, which considers the specific factors and processes determining knowledge creation and innovation in these sectors.

Specifically, we argue that in this kind of industries the innovation process presents three important characteristics (section 2):

- it has an interactive dimension;
- it has a re-combinative character, i.e. it is largely based on the use of (often) already known concepts and elements, the recombination of which leads to original improvements in products and processes;
- it is mainly based on the use, transfer and creation of tacit and local knowledge through informal searching processes,

These properties of learning involve important spatial and relational dimensions, which go far beyond the notion of localised knowledge spill-overs, which has been often used in economic models (section 3). Rather, these dimensions can be better conceptualised and understood relying on the concept of networks and systems. We argue that it is possible to identify three different types of networks, that may correspond to alternative forms of organisation of interactive learning processes and hence of pattern of knowledge creation and innovation within a regional innovation system. In particular, we suggest that the learning regions are those territorial networks, where integrative capacities and strategies are developed, which allow the efficient coordination of the decentralised interactive learning processes among firms and other institutions.

Finally, in Section 4, we suggest that regional innovation policies should adopt appropriate methodologies in order to promote the creation of a "learning region" and that the approach of Territorial Knowledge Management (TKM) can be useful to this task. Section 5 concludes the paper.

2. Innovation as the outcome of processes of knowledge accumulation and interactive learning

According to the traditional approach in industrial studies, innovation is promoted by various factors, which operate both on the demand and on the supply side, as indicated in figure 1. Among the first are: the access to a specific market, the level of demand, the forms of competition and the existence of specific barriers, such as the IPR, with respect to competitors. Among the second are: the advantaged insured by lower costs and higher quality of labour, the availability of new machinery embodying modern technology and the accessibility to specialised suppliers.

These complementary factors define the viability of a new process or product. However, innovation requires also subjective or immaterial factors. First, the entrepreneurs should have the capabilities to design an original innovation project. Then, investors should positively evaluate the risk of the investment required by the project considered.

Thus, internal design capability and internal or external financial resources are two additional necessary conditions for the adoption of an innovation and they underline the key role of internal subjective factors within the firms, as these latter affect the capabilities/weaknesses to exploit external opportunities or to face external threats.

These simple considerations highlight the key role of knowledge creation for the adoption of innovation, as internal knowledge allows the entrepreneur to search, evaluate and use external technology. Thus, knowledge is needed for the technical design of the new product or process and for the management of the organizational changes related to an innovation project. Then, knowledge is also required in order to evaluate the financial risk of the innovation project.

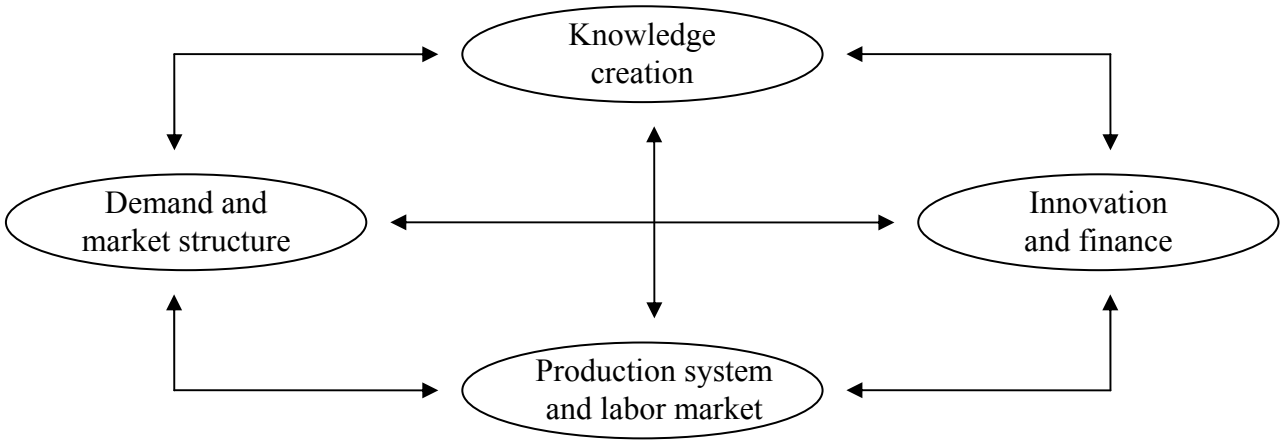


Figure 1: The relationship between knowledge creation and innovation

In this respect, knowledge is different from innovation: it represents a basic pre-condition and a key factor which interacts with material factors working on the demand and the supply side, in the process leading to innovation. This focus on knowledge justifies a study of the process of knowledge creation in the case of intermediate technology sectors, as knowledge represents a crucial ingredient of the process of adoption of new technologies and innovation.

The confluence between cognitive sciences applied to economics and innovation studies has identified some fundamental and general properties of learning. In the case of medium tech sectors, it is worthwhile emphasising the interactive and combinatorial nature of learning and the crucial role of tacit knowledge

2.1 Some basic properties of learning: the contribution of cognitive economics

The creation of a scientific breakthrough and an innovation may be analysed as the result of a process of knowledge accumulation and interactive learning.

Cognitive sciences (Rizzello, 1999) show that improvements in human knowledge are possible when outside stimuli reach the individual's cognitive system and these stimuli are integrated and processed within the cognitive system. The joint impulses or signals coming from other firms or actors should overcome a certain threshold of intensity: a condition that is facilitated by the existence of common standards of communication and routines. Any new external stimulus coming from outside the cognitive system is then analysed in order to determine whether it fits into the already existing cognitive system, categories, experiences and cultural values. In the positive case, an interactive process begins, leading to the search of consistency and compatibility. Then, the firm or actor considered can identify a new pattern or a solution to an existing problem and that stimulates the change and adaptation to the external stimulus (Gould, 1991).

The process of learning does not occur through accumulation of knowledge within firms in isolation, as innovation processes are tightly related to interactive learning processes and to various forms of co-operation within the networks constituted by firms and many other actors (Cappellin, 2003a).

Moreover, technological change is based on the original combination and integration of various abstract logical concepts and of various economic actors with different and complementary

knowledge and competencies. Thus, learning is the process whereby previous existing knowledge is selected and it is viewed in a new perspective.

This process of adaptation, re-conversion and co-evolution of the relationships between the various actors and firms has an incremental character and it follows specific paths (Laughlin 1996). The compatibility with other actors and the success in adaptation leads to the creation of new connections or to the reinforcement of existing connections, through the development of appropriate routines and institutions (Hayek 1937), which allow to save the limited cognitive capacity of individuals and organizations and facilitate the process of reciprocal integration (Rizzello, 2003 and Loasby, 2003). On the other hand, if the stimulus is not compatible with the firm or actor's cognitive system, it is rejected. In particular, a cognitive blockade or lock-in effect may occur when accessibility and/or receptivity are too low.

Accessibility is influenced by the existence of infrastructures and institutions, which may decrease the cognitive distance between any two nodes. On the other hand, receptivity is mainly related to the scope of the diversified knowledge available to the actor or the firm considered, since that allows it to identify useful forms of complementarity in the relations with other actors or firms. Clearly also time is a crucial factor, as it facilitates to perceive a continuous stimulus or to gradually adapt to it.

Whereas much attention has been devoted to the process of adoption, absorption and development of knowledge, we know much less about the critical process of knowledge integration. Yet, the strategic importance of integrative capabilities in explaining innovativeness is increasingly recognised.

In knowledge intensive environments, innovation requires a reconciliation between apparently conflicting objectives. On the one hand, specialisation by specific agents is necessary in order to be able to deepen and efficiently exploit competencies in existing bodies of knowledge and practice. On the other, innovation requires the ability to combine, or integrate, such specialized skills to be able to deliver new products and services. This tension between specialization and integration applies at the level of individual agents (e.g. individuals, firms, other research organisations) but also at the level of clusters and networks as a whole. Of course, the dilemma can be dealt with through a large variety of organizational mechanisms and principles. Hence, increasing attention has been devoted to the analysis of knowledge integration (Grant, 1996, Iansiti and Clark 1994); combinative capabilities (Kogut and Zander, 1992); architectural knowledge (Henderson and Clark, 1990, Henderson, 1992); systems integration (Brusoni and Prencipe, 2001; Prencipe, 1997).

Such emphasis on 'integration' and 'combination' highlights the fact that what matters is not the mere accumulation of productive knowledge within organizations (and the incentives not to do so), but how organizations manage to acquire new knowledge, integrate it with the existing knowledge base and exploit it in a productive context.

Tacit knowledge performs a key role in this process of knowledge integration. Processes of knowledge accumulation are often the result of a series of small (although sometimes really fast) steps in related bodies of scientific and technological knowledge, rather than "random" moves across unrelated technological areas (Teece, et al., 1994; Breschi et al., 2003). Integrating knowledge has become a widespread concern. For example, empirical evidence shows that large firms are more diversified in the technologies that they master than the products that they make, and that their technological diversity has been increasing while they have typically been narrowing their product range (Granstrand, Patel and Pavitt, 1997; Gambardella and Torrisi, 1998; Von Tunzelman, 1998). Similarly, evidence suggests that firms with higher integrative capabilities are supposedly more successful (Henderson (1992), Nesta (2004) and Nesta and Saviotti (2004)). But the same

notion could be extended to clusters and networks, rather than to individual firms (Orsenigo, Pammolli and Riccaboni, 2001).

The creation of new knowledge implies an intense process of interaction (Nonaka and Konno, 1998), which is characterized by transfers both of tacit knowledge and of explicit knowledge and which requires face to face contacts and physical proximity as well as contacts through the ICT on long distance.

Tacit knowledge is both an input and an output in the process of interactive learning. Internal tacit knowledge has to be combined with other's tacit knowledge and with codified knowledge. Tacit knowledge generates other tacit knowledge and the socialization process may lead to generate new codified knowledge.

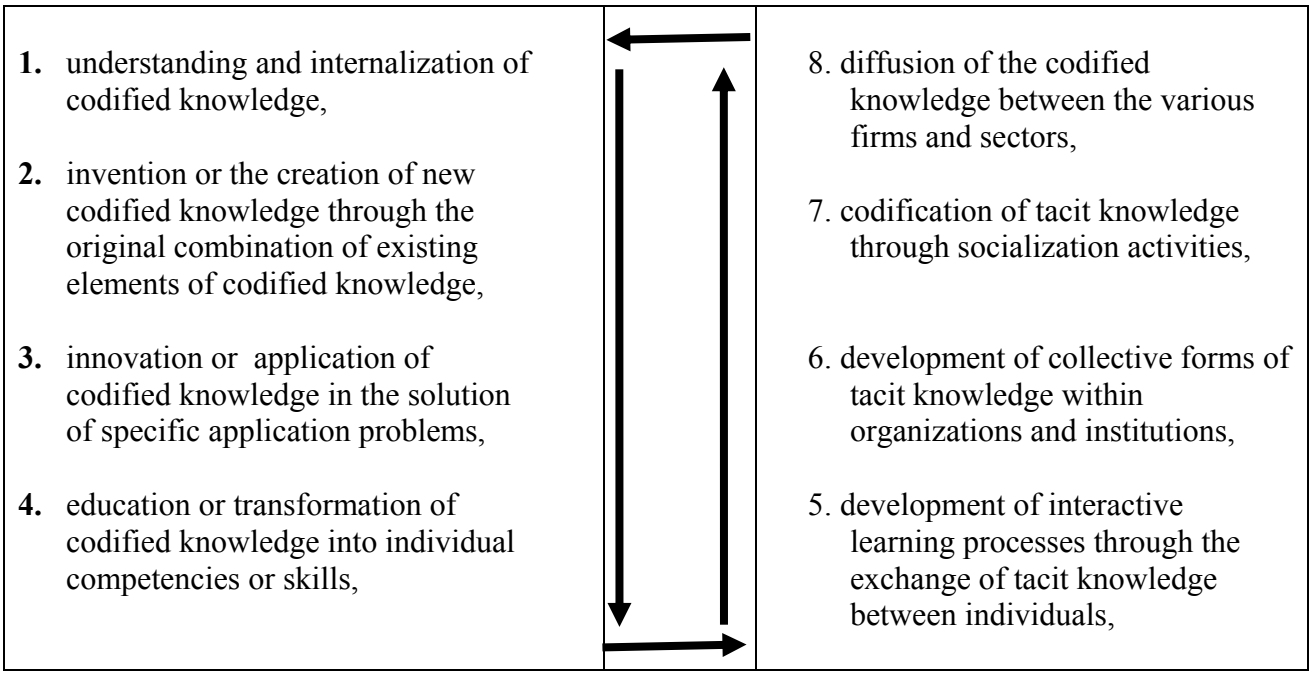


Figure 2: The cycle of knowledge creation

In particular, the creation of knowledge is the result of a cognitive process, which may be represented as a cumulative cycle made of different phases, where the role of tacit knowledge is crucial (Cappellin 2005). In fact, tacit knowledge is necessary to both the understanding of codified knowledge imported from outside (phase 1), to the capability to combine in an original way codified knowledge (phase 2), and also to the capability to apply the codified knowledge to the solution of specific problems in different localized contexts (phase 3).

On the other hand, codified knowledge is crucial in the process of development of the competencies of the various individuals, in the education activities (phase 4) and thus in the development of tacit knowledge.

The availability of tacit knowledge by individual actors represents the base for the development of interactive learning processes which lead to the further development of knowledge (phase 5). Thus, the process is cumulative. Moreover, interactive learning processes lead to the development both of individual knowledge and of tacit collective organizational and technological knowledge (phase 6), which characterizes specific groups of individuals, firms and organizations. The socialization of

tacit knowledge within the groups, firms and organization is preliminary and instrumental to their codification and transformation into tacit knowledge (phase 7).

When socialised, tacit knowledge can be more easily organized, maintained and diffused within the firms and organizations and also between the various firms and organizations (phase 8). Finally, the diffusion of knowledge and the transformation of local knowledge in diffused knowledge and their access is not sufficient if it is not supported by the development of the receptivity of the involved actors. Yet, the development of understanding capabilities requires again the availability of tacit knowledge (phase 1).

The creation of new knowledge is the result not only of the combination or of new connections between pieces of codified knowledge, but rather of the availability and development of tacit factors, such as individual, organizational and collective/territorial competencies. Thus, technological codified knowledge is only a component of the innovation processes.

2.2 The complex nature of tacit knowledge

Tacit knowledge plays a key role in the informal process of searching for a solution to local problems, which is particularly important in the innovation adoption by SMEs or in medium technology sectors and which is different from the formal search characterising the R&D activities.

The concept of tacit knowledge is often defined in a residual perspective as it is opposed to the concept of codified knowledge. Moreover, knowledge is often considered as a stock. However, rather than simply as a stock or a resource, tacit knowledge could be better understood as the availability of various capabilities, which are localized or idiosyncratic and cannot easily be transferred. In particular, tacit knowledge may refer to the competencies which explain both the process of how each actor behave and the process of how he interacts with other actors.

Tacit knowledge is related to the capabilities to create specific “patterns”, “frames” and “mental models” for interpreting the world. These capabilities define also at the same time the receptivity to external information, some of which will be “understood and accepted”, while other fragments will be rejected because they are incompatible. Tacit knowledge manifests itself through the ways in which actors select and interpret “weak information” or “insider information”: such information may not be identified or understood by individuals, who do not have accumulated adequate experience and knowledge of the state of the art in a specific field, and therefore they are incapable to assign to it a specific meaning and to adapt it to a specific context. At a more aggregate level, e.g. various firms belonging to the cluster, tacit knowledge lies also behind the ability of differentiated agents to share a common cognitive frame, common conceptions and an idiosyncratic knowledge, which prompts them how to look at things from a different perspective.

Tacit knowledge or capabilities are also related to the attitude to risk taking, insofar as characteristics such optimism, entrepreneurship and the ability to look forward are not simply pure psychological traits and they do not simply derive from explicit mental processes, but they are embedded in specific “ways of doing things”, partly affected by past experience.

“Creativity” is also essentially based on tacit knowledge, as the capability to recombine and restructure different fragments of knowledge in an original way is in itself tacit, since what has not been thought cannot be codified. Creativity is not only a capability of an artist, as in the case of the concept of “symbolic” knowledge, but it is crucial also in the elaboration of new theories by a scientist, as indicated by the concepts of “analytical” (science based) knowledge or “propositional” knowledge. Similarly, the capability to combine different technologies in a creative way, in order to

solve applied problems is a form of tacit knowledge and it is indicated by the concept of "prescriptive" knowledge and of "synthetic" (engineering based) knowledge.

Tacit knowledge is essential not only in explaining the capabilities of the individual actors to think and to act, but also in explaining their capabilities in the interaction with different actors. In particular, tacit knowledge is at the basis of that "automatic" coordination, which develops when actors are capable to react to external stimula following specific "routines", which are often not explicitly codified and are only based on experience.

Tacit knowledge is also intrinsic to the very the capability to learn, which is crucial, as evolution and survival are the result of a learning process. "Learning to learn", as in the case when learning occurs through repeated interactions and the sharing of common schemes of interpretation of external information, is the result of processes of construction of tacit routines and heuristics, which might also influence how each actor is combining "exploration" activity with an "exploitation" activity.

Furthermore, relational capabilities may consist in the organizational and managerial capability to govern or steer the action of other actors, as indicated by the concepts of leadership and governance capabilities, which involve some form of tacit knowledge and are more similar to an art than to codified knowledge. A relational form of tacit knowledge is also represented by the reputation and thrust, that an individual firms or entrepreneur enjoy in the local business community.

Physical contiguity and embeddedness in the local territory make it easier to share or to transfer the individual competencies and allows a rapid circulation of knowledge and innovations. On the other hand tacit knowledge is harder to be transferred at long distances, as it requires personal contacts and a deep reciprocal knowledge. However, in some cases, the lack of geographical proximity may be compensated by adequate organizational or institutional proximity.

Finally, a key difference between tacit and codified knowledge is the fact that tacit knowledge, while being more difficult to transfer among distant actors, might be easier to recombine than codified knowledge. In fact, whether the "codes" inherent in different bodies of codified knowledge are excessively stringent, they can be incompatible with each other. They can impose univocal interpretations and therefore rigidities in the use and modification of knowledge itself. In these cases, recombining knowledge from different agents, sectors, disciplines and countries can be easier when the tacit component is very strong.

2.3 The role of tacit knowledge, informal research processes and competencies

Technology in the medium tech industries is often characterized by a high degree of complexity, meaning that a high number of heterogeneous physical components has to be assembled in the final product and there is a large number of possible forms of interdependence between these complementary components. Also, knowledge in these sectors is highly fragmented and distributed among various specialized, small firms. In these industries, firms mainly produce intermediate products for other firms rather than final products for the consumer market.

Many innovations in medium-technology sectors are based on technological paradigms, which started a century ago, but have been improved by engineering expertise and by integrating experiences from other technological disciplines, like material sciences or nature sciences.

Machinery and transport equipment productions represent typical example of medium tech sectors. They are characterized by a high degree of modularity, specialization of firms, forms of vertical

quasi-integration between companies which are organized in complex and continuously changing supply chains. The production process in mechanical industry may be distinguished in many different phases and also the final product is the result of the assembly of a very high number of intermediate components. That contributes to explain why economies of scale may be less important for the individual specialised company and why firms have typically a small size. SMEs often lack necessary human capital resources to get into continuous interaction with basic research institutes and researchers from other disciplines. Moreover, SMEs engage in less formal research activities as compared to large companies because they cannot recuperate the high fixed cost involved in routine R&D.

Thus, medium tech sectors are highly dispersed and fragmented and they are characterized by a variety of agents, competencies and fragments of knowledge. As a consequence, one observes to high competition among SMEs and also to the need to promote cooperation, in order to exploit the potential of complementarity between widely dispersed components and actors.

These specific characteristics of medium tech sectors are related to the different characteristics of the innovation and knowledge creation process in these sectors with respect to high tech sectors. innovation processes in the medium and low technology sectors and in the small and medium size firms depend on the availability of tacit knowledge, such as combinatorial capabilities, and on not formalized search activities, based on interactive learning processes within networks of firms.

Thus, the distinction between codified and tacit knowledge can be matched with the distinctions between the formal research activities and the informal search activities and the distinction between the development of innovation/inventions and the development of internal competencies within firms. That allows to illustrate the different characteristics and factors of the process of knowledge creation and innovation in medium-tech sectors and in SMEs with respect to the process of knowledge creation in high-tech sectors and in other firms and organizations, which is considered in most of the literature and policy debate on innovation.

As indicated in table 2, innovation processes can be characterized by specific forms of combination between different inputs, processes and outputs (Cappellin, 2004).

In the medium and low technology sectors where SMEs are dominant, innovation processes depend on the availability of tacit knowledge, such as combinatorial capabilities, and on non formalized search activities, based on interactive learning processes within networks of firms, and on the development of competencies.

On the contrary, the development of interactive learning process in the academic institutions is characterized by: codified knowledge, formal research activities and development of competencies, which are related to the education function of universities.

In large firms, the process of knowledge creation and innovation is characterized by tacit knowledge, formal research activities, leading to the development of inventions/innovations. Finally, in the case of modern knowledge intensive business services (KIBS), interactive learning processes are related to the use of codified knowledge, to the effort in informal research activities and that leads to the contribution of these advanced services to the development of inventions/innovations, especially in the industrial firms which are their clients.

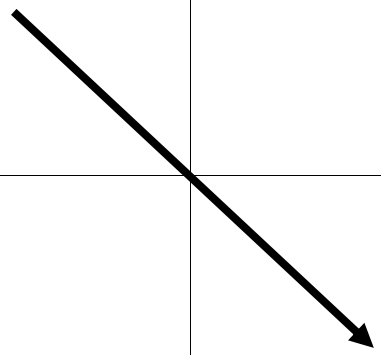
University nstitutions	Large firms	**Formal research**	**PROCESS**	University institutions	Large firms
Knowledge intensive services	SMEs in non high-tech sectors	**Informal research**		SMEs in non high-tech sectors	Knowledge intensive services
Codified knowledge	**Tacit knowledge**	**INTERACTIVE LEARNING PROCESSESS**		**Competencies**	**Invention or innovation**
INPUT				**OUTPUT**	
University institutions	SMEs in non high-tech sectors	**Competencies**	**OUTPUT**		
Knowledge intensive services	Large firms	**Invention or innovation**			

Table 2: Input, processes and output of knowledge creation in different organizations

3. The territorial nature of learning processes

The emphasis on tacit knowledge and on interactive learning leads to focus on the relationships between the cognitive analysis of learning processes and the analysis of geographical concentration of innovative activities. Indeed, much of the literature on innovative and productive clusters is based on the recognition that the local, tacit and interactive nature of learning constitutes an essential constituent of agglomeration economies.

3.1 The concept of local knowledge spillovers

To a considerable extent, and especially in the econometric literature, this intuition has been operationalised through the concept of knowledge spillovers. Different types of methodologies: estimation of knowledge production functions as in Jaffee (1989), Acs et al (1992 and 1994), Audretsch and Feldman (1996), Feldman and Audretsch (1999), Feldman and Florida (1994); use of patent citations to track direct knowledge flows from academic research into corporate R&D (Jaffee et al (1993), Almeida and Kogut (1997)); and an immense set of empirical case studies and

narratives confirm that indeed important localisation effects exist in innovative activities.

However, we still know very little about how these processes develop. It has become increasingly acknowledged that the evidence supporting the role of knowledge spillovers is largely indirect and that it is quite difficult to clearly separate knowledge spillovers from other types of pecuniary extenalities and more generally between Marshallian externalities and more classic urbanisation externalities or even natural endownments (Glaeser et al., 1992, Ellison and Glaeser (1999), Henderson (1999)). In many cases, the definition of spillovers that is used includes only physical proximity (physical distance) to universities or research centres, although other studies extends the definition of spillovers to include also the proximity of a high number of firms belonging to the same sector (see among others, Autant-Bernard, (2001), Autant-Bernard and Massard, (1999)).

Perhaps more important, as forcefully argued by Breschi and Lissoni (2001), it is has proven hard to precisely show how knowledge spillovers actually work and even whether they can legitimately interpreted as spillovers. To begin with, in econometric studies spillovers are often identified as a sort of a residual, rather than directly. But that residual might actually include many different processes that do not necessarily coincide with knowledge spillovers. Thus, for instance, in diverse instances, the pool of knowledge that should constitute the very origin of knowledge spillovers seems to be embodied in specific people and/or in a pool of specialised workforce, as argued for example by Zucker et al. (1998, 1998a) and Almeida and Kogut (1999).

Similarly, knowledge within a clusters in many cases does not appear to simply "spill over". Rather, access to such knowledge seems to require deep involvement in the research process and bench-level scientific collaboration and the conscious investment of resources not simply to search for new knowledge, but to build the competencies to absorb the knowledge developed by others. Finally, in other cases, knowledge flows occur via (localised) mobility of researchers and of the workforce and are mediated by market transactions or other institutionalised or quasi-institutionalised mechanisms involving not simply mutual trust and face-to face contacts, but highly complex economic and social structures.

3.2 The concept of relational space

More generally, in the previous stream of literature, the nature of the process of knowledge creation is apparently a-spatial, or space is conceived as a pure physical variable. Other studies, mainly in the field of regional economics, have attempted to go beyond this simple representation. Regional economics for its special interest on territorial structure and spatial flows (i.e. migrations, investments, information, exports) has traditionally focused on the tight complementarity between the spatial flows and the process of diffusion of innovation, both within industrial districts/clusters at the local level as also between the centres of the urban system at the national and international level. Physical space is therefore coupled with "relational" space, made by all the different relationships built among local actors. For example, the well-known concept of "milieu innovateur" refers to this more complex concept of space (Capello and Faggian 2005).

In the regional approach the channels through which the relational capital becomes collective learning are defined as a high mobility of local labour force, stable and fruitful relationships with local customers and suppliers and spin-offs.

3.3 The spatial dimension of the cognitive processes

A third field of literature, which sheds some insights into the explanation of geographical agglomeration, is represented by the studies of cognitive economics, although they apparently have an a-spatial character. In fact, as this literature emphasises the combinatorial and interactive character of the processes of knowledge creation, it implicitly stresses the spatial nature of the process of knowledge creation. For the purposes of this paper, it might suffice to emphasise that both the combination of complementary pieces of knowledge and the interaction between various complementary actors are facilitated by a closer geographical proximity and greater cognitive proximity.

In fact, there is a tight correspondence between the main components of the cognitive processes, as indicated by the literature in cognitive economics:

- the type of the external stimulus,
- the strength of the external stimulus,
- the search for consistency and integration and the process of adaptation,
- the search and the integration of complementary resources and capabilities,
- the interactive learning process leading to knowledge creation,
- the path-dependent evolution of the knowledge creation process,
- the key role of institutions in the knowledge creation process,

and the spatial dimension of these cognitive processes.

First, the local environment and the aim to solve the problems of local users is important in providing a stimulus to innovate to firms. In fact, spatial concentration of economic activities does not only allow to exploit economies of scale but also of economies of scope or synergies between various activities, as existing knowledge may be reconverted to satisfy new emerging needs.

Second, the strength of the external stimulus is important in leading to knowledge creation, as a low cognitive distance facilitates the identification of weak signals and collaboration opportunities. This is the case for example, of users - producers relationships, which might evolve towards co-makership and play an important role in the process of innovation in industrial clusters.

Third, the external stimulus should be compatibles with the internal integrity of the local production system and it should lead to a gradual process of adaptation (Rizzello 2003). In fact, the aim to preserve the identity and to insure the survival of the local economy facing the external competition may represent a powerful challenge leading to innovation.

Fourth, innovation requires the search and the integration of complementary resources and capabilities. In fact, firms initially look for the support of local suppliers and search first of all complementary resources existing at the local level. The diversity of metropolitan areas (Cappellin 2000) and also the sectoral specialization of industrial clusters (Steiner, 1998) facilitate the identification of complementary capabilities, not only because they decrease transaction costs between agents, but also because they may enhance business opportunities and entrepreneurship, due to the high diversity of origins, sectors, competencies existing in these areas and the easy access to a wide scope of new emerging needs and of complementary resources.

Fifth, knowledge creation is characterized by specific paths of evolution and it is tightly related to the sectoral specialization, the industrial culture and know-how existing in the innovation systems to be considered. These factors may facilitate the early identification or the design of new patterns, combining previously existing ideas and pieces of information and knowledge. At the same time, however, they also constrain the discovery of new pattern in the attempt to assure the consistency

and compatibility with existing solutions: path-dependency and in some case to "lock-in" effects may arise in these circumstances.

Knowledge creation is characterized by specific paths of evolution and it is tightly related to the sectoral specialization, the industrial culture and know-how existing in any specific innovation system. These factors may facilitate the early identification or the design of new patterns, combining previously existing ideas and pieces of information and knowledge.

Sixth, the importance of institutions in the process of innovation implies that the local history and memory - which are the result of centuries of interdependence between local actors - are a distinctive characteristic of the individual places. Common history leads to common cultures, patterns and visions of the future, reciprocal trust and also to the creation of local institutions and routines, i.e. the local "social capital" (Maskell 1999), which facilitates connections and decrease the cognitive distance between local actors.

4. From knowledge spill-overs to learning networks

As it is recognised that learning and innovation are embedded in physical, cognitive and relational space, it becomes necessary to understand much better how knowledge flows are structured within a specific geographical area. The notion of networks is useful in this regard and network analysis has become a fundamental conceptual and technical apparatus guiding research in this field.

A network can be characterized by:

- nodes which, according to the network considered, may be firms or individual actors or even abstract building blocks, such logical concepts, and are characterized by different internal characteristics,
- flows or links, which may have different intensity and nature, such as material (i.e. intermediate products or equipment) or immaterial (i.e. finance, information or patents), and may be direct or indirect through intermediary nodes,
- distance among nodes, which may be measured according to the flows considered and can be represented by geographical distance, transaction costs, difference in technology levels, organizational structures and cultural frameworks. It major determinants are the differences in the characteristics of the various nodes.
- infrastructures, which reduce the distance, facilitate or hinder the circulation of the flows between the nodes and may have a material, such as logistic infrastructures, or immaterial nature, such as norms or institutions or "social capital".

Knowledge networks are characterized by direct and indirect flows of information, codified and tacit knowledge between various firms and qualified workers. They are hindered by transaction costs and differences in the technology levels or differences in the cognitive framework. Research organizations, higher education institutions and scientific associations represent the key infrastructures.

Knowledge networks can be hardly conceived as static. The structure of knowledge and innovation networks may change due to:

- change in the links or in the paths between nodes, as indirect links between two disconnected nodes may be transformed into direct links;
- change in the intensity of the flows;
- change of the nodes, as new nodes may be created and previous nodes may disappear
- change in the nature of the flows, as the nodes may exchange various hard or soft inputs or outputs.

In particular, the intensity of the interaction between the various nodes of a network through the existing links is related to the interactive characteristic of technological change, which is the result of interactive learning processes.

Moreover, the speed of change of the links between the various nodes of a network through the creation of new links is related to the combinatorial characteristics of technological change, which is the result of an original combination of already known, but previously disjointed logical concepts or concrete artefacts.

Thus, the adoption of a network perspective allows us to focus on some further relevant aspects of the process of technological change (Cappellin 2003a). In a network perspective, technological change may be interpreted as the result of the continuous or gradual search by each node, of the most appropriate level and form of integration or co-operation with the other nodes or actors within the network. In this respect, technological change can be analysed as being similar to a process of adaptive learning and of iterative adaptation of the direct and indirect links between any pair of nodes in order to maximize their mutual interaction and integration.

4.1 The different nature of local networks

Networks and clusters may have different characteristics and they may be distinguished in the following three types (Cappellin 2003b), each of which is characterized by a different pattern of knowledge interaction.

'Ecology networks', sometimes assimilated to 'agglomeration economies'. They are characterised by strong interactions. Ecology networks are constituted by relationships characterised by objectively observable stable interdependence. They are also based on behavioural adaptation, strong specialisation, complementarity and idiosyncratic relationships and lead to various forms of traded and untraded interdependencies or spill-over effects. Basically ecology networks are the result of geographical agglomeration and they characterize the areas of concentration of the firms belonging to the same sector or urban area. Clearly also information and communication technologies may favour the creation of these types of networks. They are the result of external economies and technology spill-over, which are also defined as "localization economies" or "urbanization economies" and which spread in a rather automatic and quasi - random way between the various firms and actors living in a specific local environment.

'Community networks', are based on the sense of identity and common belonging. These subjective element distinguishes them from ecology networks. Thus, community networks require the sharing of an homogenous culture, common values and are characterised by the existence of trust relationships, common institutions and specialised intermediate social organisations, which are defined as "social capital" (Coleman 1988). These networks are places of collective learning and of the development of a common production know-how. However, they lack the capability of central coordination and strategy making. Typical case of community networks are the industrial districts or clusters and regional innovation systems.

'Strategy networks' are based on cooperative agreements between firms and other organisations. These are the result of negotiations, agreements on specific strategies and the creation of formal and explicit 'joint ventures' by the participating actors. Strategy networks also imply the reciprocal commitment of specific resources, which are invested in order to achieve common goals and future but uncertain benefits. Strategy networks imply forms of central coordination, the creation of procedures for the exchange of information, the codification of individual implicit knowledge and

the investment in the creation of collective codified knowledge. Strategy networks may be represented both by widely geographically dispersed strategic alliances made by pool of large and small firms or by local clusters and regional innovation systems, which explicitly want to become a "learning region".

Table 2
The phases of evolution in a cluster of SMEs and the process of knowledge creation

	Ecological networks	**Identity networks**	**Strategy networks**
Self-consciousness	Objective homogeneity	Subjective factors, intended relationships, sense of identity	Subjective factors, intended relationships, joint aims
Formalism	Informal relationships: imitation	Informal relationships: trust relationships	Formal relationships: contracts
Type of relationship	External economies	Exchange	Joint investment
Differentiation process	Homogeneity	Autonomous specialization	Division of tasks
Form of interaction	Interdependence	Cooperation	Strategic coordination
External support	Geographical proximity	Common infrastructures, intermediate institutions and social capital	Joint decision making and policy making
Key knowledge base	Symbolic Knowledge	Synthetic/symbolic knowledge	Analytical/ Synthetic knowledge
Key knowledge phase	Exploitation	Examination/ Exploitation	Exploration/ Examination
Knowledge interaction	Knowledge spill-over	Interactive learning	TKM and R&D
Main activity	Low tech	Medium tech	High tech

Industrial clusters of medium tech sectors are often similar to the model of the "identity networks". These various types of networks are characterized not only by the different type of material relationships, but also by the different concept of space or of proximity (geographical, relational and strategic) that they involve and by the different types of knowledge base of the various productions and of knowledge phase, in which the actors are mostly active. That determines different types of interaction in the knowledge process between the various actors. As indicated in table 2, medium tech activities are characterized by synthetic (engineering based) and sometime symbolic (creativity based) rather than analytical (science based) knowledge and the key knowledge phases seems to be the examination phase, as it is implied by the tight specialization and cooperation between the various firms. That explain why clusters of medium tech activities are characterized by the importance of interactive learning processes and less by simple knowledge spillover, while an explicit governance of knowledge interaction is still lacking.

4.2 The learning regions and the concept of integrative capabilities

Defining a region as a 'learning region' means that the actors of the system are committed to an interactive learning process, which allows the development of knowledge, know-how and other capabilities required for creating innovation and maintaining regional competitiveness (Maillat and Kebir., 1999).

The objective of a 'learning region' is the integration of tacit or implicit traditional knowledge - which is bounded within the local context - with the codified knowledge available at the world level, in order to stimulate the regional endogenous potential.

A 'learning region' may represent the final outcome of the evolution of an 'industrial district', which changes over time as a result of the transformational role of the processes of learning, adaptation and innovation within the network.

In order to understand how a region becomes a learning region, it is necessary not only to identify the specific structural characteristics of the network (e.g. centrality, density, connectedeness, ties strength etc.), but also the specific functions played by different nodes within such networks (e.g. brokers, integrators, gatekeepers, etc.). The idea that focal nodes are key to understand network dynamics is not new. For instance, it has been shown that successful product and process innovations require *champions* (Allen, 1977; Roberts 1987; Rothwell, 1990) and Cohen and Levinthal (1989) have emphasised the importance of role played by gatekeepers to access externally generated knowledge. This line of enquiry has recently been newly approached in recent years, with the explosion of interest in network dynamics.

In particular, as mentioned earlier, increasing attention has been devoted to the concept of integrative capabilities and on the agents who embody these competences. We propose that these capabilities and agents play indeed a fundamental role in learning regions where collective learning and recombination are key processes leading to innovation and technological progress. However, we still know little about these competences and agents. For example, some authors discuss technology 'brokers', who recognize, store, blend, and transform technologies (Hargadon and Sutton, 1997), while Brusoni et al. (2001) talk about 'integrators' which coordinate loosely coupled networks of specialized suppliers. However, little is still known empirically about the actual differences between, for example, brokering and integrating activities. They both have to do with coordinating specialized agents, but how they differ and how such differences impact on networks' evolution and performance is still unclear (and hard to measure).

Indeed, there are many different ways through which such integrative capabilities can be conceptualised and operationalised. In particular, one may distinguish between two fundamental and prototypical forms of such capabilities and functions within networks: knowledge brokerage and knowledge integration proper.

Intuitively, it is relatively easy in principle to distinguish brokers from integrators. Brokering can be conceived as the activity of alerting 'distant' agents that they have common interests and complementary capabilities (e.g. 'yellow pages' type of function). A broker may transfer some information between agents, but with little or no elaboration. Knowledge integration entails instead placing the contribution of others in a wider 'interpretive' framework which enables the evaluation of the function and value of the contribution of each. It requires therefore a higher level of understanding of the activity of others than brokerage. Knowledge integration involves also the ability to act upon and modify the contribution of others in order to identify and manage interdependencies and critical issues. Yet, operationally distinguishing –let alone measuring – these concepts is much harder and further research is needed.

4.3 The role of institutions in the process of interactive learning

A key characteristic of identity and of strategy networks is the role of institutions, which allow to integrate the different actors of the local economy and to define a joint strategy.

New institutional theory argues that the strategic significance of institutions in development processes lies in the economies that its functioning provides. Barriers hindering self-sustained growth processes are often attributed to deficiencies and poor performance of the institutional network

The behavior of institutions can:
- generate external and internal economies of scale,
- reduce transaction and production costs,
- increase trust among economic and social actors,
- favor economies of scope,
- improve entrepreneurial capacity,
- increase learning and relational mechanisms,
- reinforce networks and cooperation among the actors.

Knowledge networks depends on the development of so-called intermediate institutions, such as regional and local governments, local credit organisations, local education institutions, labour agencies, trade unions, chambers of commerce, and industry associations.

Thus, a wide range of institutions is required in the process of innovation. The diffusion of knowledge and innovation creation in a specific network or sectoral/regional/national innovation system depends on the "institutional thickness" of the innovation system to be considered.

Due to their interactive nature, learning processes involve groups of individuals and calls for the development of links, networks and social and cultural institutions and conventions among different actors. The passage from the individual learning to the interaction among individuals implies the co-ordination of the interaction process.

According to cognitive theories, The exchange of knowledge cannot be effectively insured coordinated by conventional markets. The creation of new connections or the reinforcement of existing connections implies the compatibility with other actors, the success in the adaptation and the development of appropriate routines and institutions (Hayek 1937). According to Marshall order makes room for creativity, organization aids knowledge, as stable pattern may be used as euristics. Institutions allow to save the limited cognitive capacity of individuals and organizations and facilitate the process of reciprocal integration (Rizzello, 2003 and Loasby, 2003).

A rather diversified typology of institutions play a leading role in defining a long term strategy of innovation of SMEs within the different regions. Institutions and other forms of "social capital" play the role of immaterial infrastructures which organize the knowledge flows between SMEs within the clusters. Institutional solutions to overcome lack of resources by SMEs are regionally specific and influenced by long-term historical and cultural heritage within the region.

The role of institutions is that to create new routines or baseline, which insure the adaptability of connections between actors. Institutions include any form of constraint: formal and informal. They can be create or they may simply evolve over time. Therefore the creation of institutions enhancing the connectivity of knowledge should be a central concern of policy.

The multiplication of players and layers of negotiation – international, national, and local – demands for different models of government, called governance, based on organisational structures of interaction and partnership, that more and more characterise local societies. Governance is the challenge of steering and positioning complex organizations. These can be committees, research groups, firms, networks, communities, regions and international agencies.

The expression governance is used with respect to decision making systems, where the decisions are not taken according to the traditional hierarchical processes by a public authority ("government"), but rather through open forms of collaboration between a plurality of public and non public actors, which may differ between the various specific areas of policy and between the various levels of government.

Governance is made by complex policy networks. The decision making processes may include forms of horizontal and vertical negotiation, where the exercise of a hierarchical control is only one of the components and most often not the major one.

Economic development, then, is stimulated in those territories characterised by highly evolved, complex and flexible institutional systems. That is why training and research institutions, entrepreneurial associations, unions and local governments can more efficiently use available resources and improve competitiveness when firms are integrated into territories characterized by thick relational networks.

5. The approach of "Territorial Knowledge Management"

In the perspective of the creation of a "learning region", regional innovation policies should identify and design appropriate methodologies in order to organize the cognitive relations between the various local firms and actors,

The approach of Territorial Knowledge Management (TKM) is based on the concepts of cognitive economics, and it aims to promote the innovation capabilities of a regional production system through the growth of the "territorial knowledge capital" and the development of interactive learning processes (Cappellin, 2003).

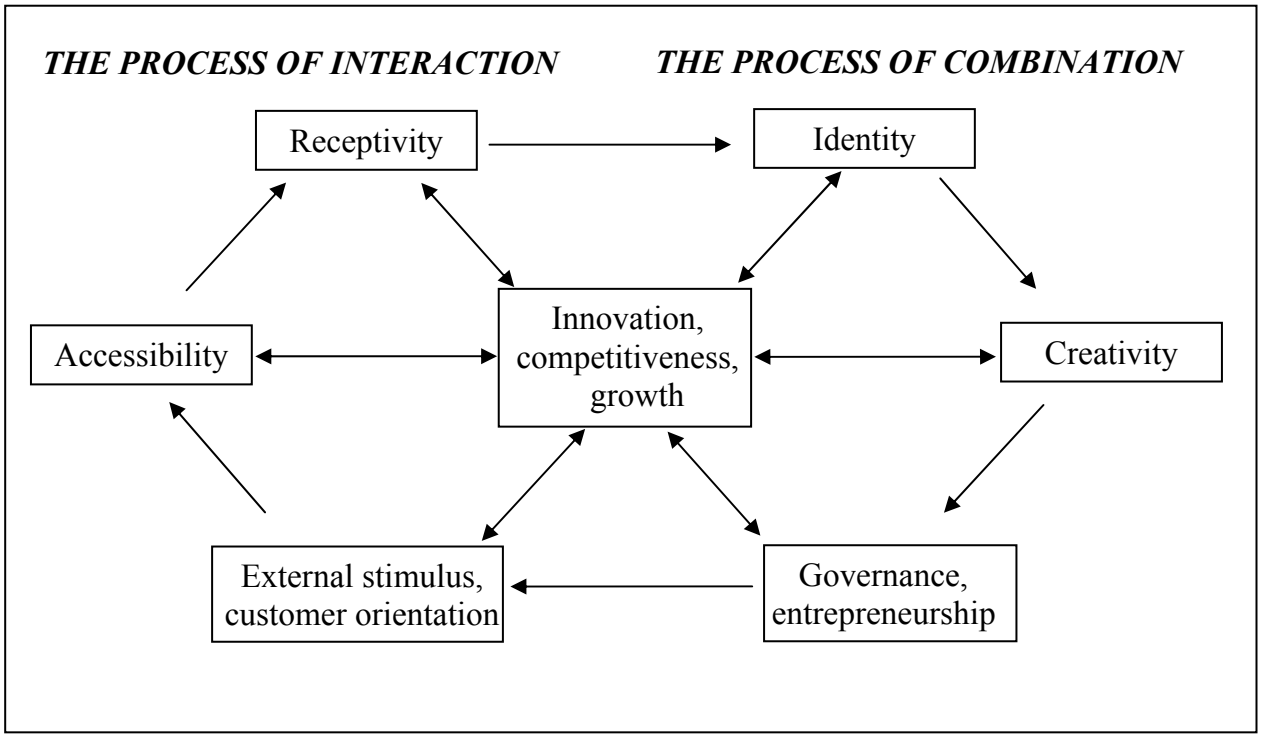


Figure 3 – The six dimensions of TKM - Territorial Knowledge Management

In particular, Territorial Knowledge Management aims to:

a) promote the creation of the Territorial Knowledge Capital (TKC), by accelerating the speed of circulation of information between local actors and between these latter and external actors, by avoiding lock-in effects and by managing the 6 levers to be described below;
b) extract the value of Territorial Knowledge Capital through the enhancement of innovation which represents a key factor for the competitiveness and growth of a regional economy;
c) create new innovation networks within the regional innovation system and to build new formal and informal institutions, infrastructures, norms, rules and routines which may manage ("governance") the innovation networks and the interactive learning process;
d) provide a quantitative accounting framework to measure the local strengths and weaknesses in the perspective of the knowledge economy.

Territorial Knowledge Capital is given not only by the summation of the "human capital" of the individuals in a given region and by the "intellectual capital" of the various firms but also by the original combination of these two components and it represent a form of collective tacit knowledge.

TKM interprets and manages the relationships between the local actors and between these latter and external actors as cognitive relationships. TKM emphasises the process of networking and integration and relies on the concept of interactive learning and knowledge creation as developed in social sciences and cognitive sciences.

As Knowledge Management aims to transform individual tacit knowledge into corporate codified knowledge, similarly Territorial Knowledge Management aims to transform the internal knowledge of the various firms and regional actors into localized collective knowledge, to be shared between all actors of a sectoral/regional cluster. It also aims to facilitate the acquisition from outside of knowledge, which may be crucial for the competitiveness of the overall regional production system.

TKM aims to organize the cognitive relationships between the firms in the case of local clusters or networks. It aims to make more explicit and formal the organization of knowledge interactions among firms and other agents in a traditional production system, whenever – as it is often the case – the processes through which information and competencies circulate and diffuse are too implicit, complex and slow.

According to the approach of Territorial Knowledge Management (Cappellin , 2003b) there are six factors/levers (figure 1), which represent key preliminary and instrumental conditions for the development of interactive learning processes within a cluster and for the codification of tacit knowledge and its transformation into codified knowledge

These factors allow to focus the various policy instruments in the governance of the learning networks in a regional innovation system on a limited number of dimensions, which are tightly related to the factors of the processes of knowledge creation identified by the literature in cognitive economics.

1. **Focus on customers satisfaction**. The adoption of an innovation is the result of the focus on a localized framework and of the clear definition of a specific problem, which calls for a solution and motivates to a search of different complementary competencies. Cognitive processes and innovation within firms are the result of repeated attempts and a gradual search activity, stimulated by the motivation to reduce the tension created by specific problems and the challenge that these latter may represent to the survival of the firm, rather by the explicit desire to seek a profit maximization solution, which is the result of a deductive reasoning. Tacit knowledge is crucial in this phase since the capability to apply the codified knowledge to the solution of specific problems in different localized contexts has clearly a tacit dimension.

2. **Manage accessibility and technological capital**. Since cognitive processes and innovation in the firms often develop in the framework of a specific "local" problem and they require in-depth knowledge of clients needs and of suppliers complementary capabilities, geographical proximity and appropriate technologies, such as ICT, may favor the development of the relations with various other actors and firms. The access to external complementary competencies and the access to a variety of building blocks of codified and of tacit knowledge requires the creation of those hard and soft infrastructure both in a local context and at the interregional level, which allow to organize the knowledge and innovation networks. The development of understanding capabilities requires the availability of tacit knowledge. In particular, tacit knowledge is crucial in this phase since friendship relationships, leadership and reciprocal esteem and trust are at least partly tacit factors tacit factors.

3. **Manage receptivity and human capital.** The openness of the various actors and nodes within the knowledge and innovation networks should be enhanced, in order to avoid lock-in effects and to alert them to the need of accessing complementary external knowledge and of assimilating it. The capability to interact of the various actors involved in an innovation process may be considered as a form of tacit knowledge and it is hindered not only by the cognitive distance determined by differences in the education level, cultural background, but also by the different sectoral or technological specialization, the lack of broad diversified experiences and low learning capabilities. The availability of tacit knowledge by the individual actors represents the base for the development of interactive learning processes. Education enhance receptivity and the ability to use codified knowledge in the process of development of the tacit competencies of the various individuals.

4. **Building a common identity and improve institutional/organizational proximity**. Actors involved in innovation should share common aims, mental models, as also trust and loyalty. The promotion of knowledge sharing and of the willingness to collaborate requires a change in the corporate culture. The identification of common challenges to survival and development creates a sense of belonging to the same community or group and it is a pre-requisite for collaboration in innovation. Collaborative attitudes by firms in a sectoral cluster can be considered as a form of tacit knowledge and are tightly related to the creation of various intermediate institutions, such as industry associations or specialized services providers or just common agreed routines, which are part of the "social capital" of the regional economy. Interactive learning processes lead to the development not only of individual knowledge but also of collective organizational and technological knowledge, which is clearly tacit and characterizes specific groups of individuals, firms and organizations. The socialization of tacit knowledge within the groups, firms and organization is preliminary and instrumental to their codification and transformation into tacit knowledge.

5. **Lever creativity and manage internal organizational capital**. According to cognitive theories, creativity is related to pattern making or to the capability to establish new contacts between different potentially complementary information, technologies, know-how, thus leading to new discovery and inventions. Creativity is crucial in order to diversify the structure of the local economy into new productions. Creativity can not be planned in advance, being the capability to discover original solutions. However, it can be facilitated by favoring the diversity of the various actors involved in the innovation process and the exploitation of their idiosyncratic characteristics. In particular, to increase creativity firms should aim to leverage morale, empowerment and commitment of people, in order to secure to potential inventors the freedom, security and willingness to invest in risky exploratory analysis and in a lengthy process of systematic search.

6. **Insure the governance and enhance entrepreneurship**. The implementation of innovative solutions requires the capability to cope with key problems of the organization and to manage the

complex relationships between many different actors and to mobilize them. This requires entrepreneurship capabilities and the integration of knowledge with complementary material resources, in order to transform knowledge into action. The adoption of innovation requires tight collaboration of various actors and the facilitating role of intermediary organizations and institutions, which may coordinate the joint effort. The governance of the innovation process requires an explicit effort in institution building and institutional learning, as the creation and maintenance of "social capital" or of "public goods" require appropriate investments by all partners belonging to a given innovation system. The existence of routines, institutions and governance activity has a positive effect on all the above indicated phases of the knowledge management process.

According to the approach of "TKM – Territorial Knowledge Management", these different dimensions of the knowledge creation and innovation process are linked by cause and effects relations. The basic logic of their reciprocal relations is the following. The focus on specific customer needs determine a tension leading to a search for a solution and to change and it is facilitated by an higher accessibility and/or receptivity. Accessibility interacts with receptivity. The building of a common identity leads to cooperation and joint investments. Creativity emerges by the commitment of complementary competencies and from decentralization of decision making. New ideas can be translated in economic innovations only through an appropriate organization and governance.

The creation of knowledge and the adoption of innovation are the result of a cumulative process. The knowledge developed in previous periods and the internal capabilities of the individual actors affect the future path of evolution of the innovation system considered. Moreover, the process of creation of new knowledge by some actors affect their experience and receptivity to new ideas and capability to understand the emerging needs of potential users. Clearly, the creation of institutions for the governance of the knowledge creation process represent key factors for increasing the accessibility and the receptivity of the actors in a cluster and also for the development of their sense of belonging.

Territorial Knowledge Management provides a flexible and comprehensive approach in the management of the knowledge flows and capabilities of the various actors in a regional innovation system. In particular, regions specialized in medium tech productions present different characteristics from those of regions specialized in high tech productions or in low tech productions and need different priorities and different innovation policy instruments, as indicated in table 3.

Medium tech productions are often characterized by dense networks of relations at the local level, while the accessibility to international knowledge and innovation networks has to be improved and requires higher investments into material and immaterial infrastructures and services.

The international extension of knowledge networks of SMEs call for the identification of common objectives and projects with external partners, while maintaining a strong local identity. It is necessary to find ways in order to combine regional public assistance with firm collaboration in projects that go beyond their own territory.

Regional, national and European institutions are needed in order to promote international forms of cooperation between SMEs. In fact, the development of international relations requires a more stable framework, than what the market mechanisms, multinational companies or private forms of bottom-up international cooperation may be capable to provide. The creation of European networks of "centres of competence" would increase the specialization and cooperation with other regions at the international level, widen the areas of expertise and strengthen the knowledge base of existing clusters.

Table 3
Policy areas
in the Territorial Knowledge Management approach
in selected regional innovation systems

	Specific types of Regional Innovation System		
Type of network	**Strategy networks**	**Identity networks**	**Ecological networks**
Regions, sectors and firms	**Metropolitan areas High tech sectors Large enterprises**	**Industrial clusters Medium-tech sectors Innovative SMEs**	**Peripheral regions Low tech sectors Traditional SMEs**
1. Innovation stimulus	Product innovation in specialized markets and technology push	Customer needs and Supply chain integration	*Cost competition in the global market*
2. Accessibility	*High international accessibility - low local accessibility*	*Low international accessibility - high local accessibility*	Low international accessibility - low local accessibility
3. Receptivity	*High internal diversity*	High internal specialization	*Low quality of human capital*
4. Identity	High organizational and cognitive proximity	High local embeddedness and local identity	*Fragmentation and external dependence*
5. Creativity	*High investments in R&D*	*Networking and interactive learning*	Technology adoption
6. Governance	National industrial policies and companies strategic alliances	*Multi-level governance*	Public finance and public regulations

Moreover, the high specialization in specific production fields in the industrial clusters or in the "identity" networks, while being the source of a competitive advantage, may in the long run lead to lock-in effects. Therefore, various policy measures should focus on the aim to promote an higher creativity, which implies not only higher R&D investments and the availability of skilled labour, but also an higher internal diversity of the economy and society and the combination of different technological and also non technological fields of expertise through experientialism, exploration, feedback, self-assessment of new ideas and future individual and societal needs.

In particular, medium size firms have developed vertical flows of tacit knowledge in their respective value chain, but they need to be supported for developing horizontal linkages with different technologies and sectors, in order to promote structural changes within this value chain and a productive diversification, through the creation of new fields of production.

That implies a shift from a linear approach, which just promotes transfers of information and modern technology or provides customized expertise to individual firms, to a systemic approach based on networking and cooperation between various local and external actors and focuses on the creation of new business activities and of new companies.

Finally, the transition from the traditional industrial cluster model to that of a learning model requires a policy based the governance model, characterized by the flexible integration of regional actors and of these latter with national and international actors, rather than the traditional hierarchical planning model or the free market competition model. New policy tools, such as

"competence centres" or "poles de competitivitè" have to be adopted in order to integrate the actors into joint strategic projects. Differently from high tech sectors and also from low tech sectors, which seem to need national industrial policies and national public assistance, medium tech sectors are capable of selfsustained growth, based on the partial sponsorship and seed funding for specific projects by public or private organizations, the participation of credit institutions and other financial intermediaries. That implies the need for higher autonomy and to promote managerial and administrative decentralization in the identification, planning and realization of projects, as also the creation of regional networks and open discussions between private entrepreneurs, SMEs and institutions of higher education, training organisations and support service providers evenly geographically distributed.

On the contrary, areas specialized in high tech productions are tightly linked to wide international networks. That may hinder a strong embeddedness into their local innovation system. Thus, an higher local accessibility may avoid both the negative congestion costs often characterizing the most developed areas and may provide that key spatial support which is needed in the horizontal diffusion and integration between different technological sectors. The key resources for the development of these areas are the human resources and the investment in the specialized education, as that would increase their receptivity to the advances of modern technologies. Clearly, creativity and innovation in these areas are depending mainly on large investments in formal R&D activities, not only by public institutions but also by firms, due to the science based character of the high tech sectors.

Less developed areas, have different priorities and require different policy tools. The international competition in low tech productions is justifying policies focused on the aim to insure the cost competitiveness of local activities through the adoption of modern technologies. A key constraint may be determined by the low receptivity to innovation of local human resources. Thus, higher immaterial investment aiming to increase the capabilities of entrepreneurs and workers represent a prerequisite for the adoption of modern technologies. Moreover, higher investment in social capital are needed in order to promote a stronger sense of belonging or local identity, since cooperation between local actors is much weaker in these regions than in the traditional industrial clusters, specialized in medium tech production.

Thus, it is possible to differentiate the Territorial Knowledge Management strategies according to the network type of the regional innovation system considered and its respective priorities. The approach of TKM aid policy strategies to focus the action on specific knowledge factors and to identify precise indicators and milestone according to the stage of growth of the regional innovation system considered.

6. Conclusions

The process of innovation in SMEs and in medium technology sectors differs from that of large firms in high tech sectors and it indicates the limits of the traditional linear approach and the need to adopt a modern interactive approach, as indicated in the table 4. According to this new approach, focus should shift from the aim to promote the adoption of modern technology to that of enhancing internal capabilities and knowledge. The stimulus to change and innovation within firms is not only determined by the pressure of competition, the need to increase productivity and reduce costs, or the opportunity created by the supply of modern technologies and to adopt modern equipments, but rather by the identification of new markets, the aim to adapt to changes in the demand and the opportunity to satisfy new users needs. While in the linear process of innovation the formal process of R&D investment plays a key role, according to the systemic approach to innovation, solutions are gradually discovered through a process of interactive learning involving many different actors

also outside the R&D laboratories. The desired outcomes are not just the increase of productivity indicators, often interpreted as disjoint result, but rather the speed of a continuous process of innovation, where each change is the evolution of previous changes. This new approach to the analysis of innovation processes both for the high tech sectors and especially for the medium tech sectors, is leading to adopt a new strategy and policy tools shifting from top down planning and public R&D subsidies to the promotion of various types of partnerships and to more open forms of multilevel governance.

The new approach in innovation policies, which seems to be needed in medium tech activities can be clarified by responding to the questions of what, where, to whom, how and when to do in the innovation policy.

The aim of traditional innovation policies in the science based sectors is to promote innovation through public R&D, public subsidies to private R&D, public expenditure on innovative products and services or the protection of IPR. The case of medium tech activities highlights the need to focus policies in the promotion of the six factors or levers, which activate a process of interactive learning and knowledge creation according to the approach of "territorial knowledge management": stimulus, accessibility, receptivity, identity, creativity and governance.

Table 4
The process of innovation in SMEs and in medium technology sectors
differs from that of large firms in high tech sectors

	Linear approach	**Interactive approach**
Key word	Technology	Knowledge
Stimulus	Cost competition Supply - New equipment	Market orientation Demand - User needs
Process	In house R&D	Interactive learning
Outcome	Productivity increase	Continuous innovation
Policies	Public finance Public regulation	Multi-level governance Public-private partnership

The locus of innovation process is mostly geographically constraint, as innovation has a territorial dimension. A modern knowledge economy needs a cohesive view of the innovation system as a whole. A trustful and flexible co-operation between the different actors of innovation is especially possible at the regional level, due to the close spatial relationship, that facilitates the generation of innovative projects. However, clusters do not align with state-, county or other administrative borders, as network of complementary actors in the same production field may include various regions. Moreover, a territorial perspective does not hinder the fact that knowledge interactions increasingly span at the interregional and international level, as the interaction capabilities of the

various actors may be favoured or hindered by their embeddedness in a specific local environment. That explains why innovation is leading to an international division of labour and to agglomeration and exclusion phenomena.

In the model of the open innovation, innovation is the result of the interaction of different actors and of the combination of different competences and, as Adam Smith wrote, the most important form of division of labour is the division of knowledge. In fact, innovation is not the result of the individual inventor or entrepreneur, but rather the result of a processes of collective learning, which requires the interaction of many different private and public, regional and international actors. Key actors involved in the interactive processes of knowledge creation and innovation are the universities and the research institutions, the different tiers of local governments, the banks and the various intermediate institutions, which determine the regional social capital. Moreover, innovation policies should not target their actions only to firms and institutions, but also to the labour force itself, as most tacit knowledge is embedded in human beings, who are not only workers, but also consumers of the new products and services and citizens participating in democratic decision-making.

Due to these different characteristics of innovation processes, especially in medium tech sectors and in SMEs, both traditional policy making models - hierarchical planning and free market competition - are less adequate than the model of multi-level governance, which is based on the steering of the policy networks and in promoting partnership in joint strategic projects. Moreover, a complex interaction is needed between regional and national or European innovation policies since various new sectors (aerospace, environment, energy, finance, mayor international infrastructures, etc.) require higher national or European coordination. On the other hand, the network approach has promoted the discovery of the spatial dimension of innovation policies and has lead to adopt policy schemes, which focus on the regional clusters and are highly similar in the various European countries, while having different names, such as national networks of clusters, “poles de competitivitè”, competence centres, centres for expertise and technology districts or clusters.

The approach of learning networks underlines that the time is indeed a key dimension. The competitiveness of firms and regional innovation systems is increasingly less determined by low production costs or even by high quality of the products or services, than by a faster speed of the process of change with respect to the competing firms and regions. In particular, the sudden crisis or also the sudden recovery of individual industrial firms indicates the importance of the time dimension as a key competitive factor of the European industry. Innovation policies should timely react to unexpected changes, such as the sudden closure of some large firms requiring the fast reconversion of human and financial resources into new productions. Well structured production and innovation networks allow a greater flexibility, to accelerate the policy making process and to decrease the decision and implementation times, by reducing transaction and adjustment costs. Moreover, the pattern of evolution of regional innovation systems, from “ecological”, to “identity” and “strategic” networks, seems to follow an evolutionary trajectory toward the model of a modern “learning region”, which may to some extent be accelerated by explicit innovation policies.

In this paper, we have discussed the characteristics and factors of interdependence and cooperation in innovation between firms in medium tech sectors and indicated their difference with respect to those within firms in high tech sectors. Knowledge creation has an interactive and combinative nature and the flows of knowledge and information lead – both from a positive and a normative perspective – to the development of complex learning and innovation networks. Spatial factors have an important role in the process of knowledge creation and agglomeration economies may be the results of the spatial nature of the cognitive processes. Tacit knowledge represents a key feature of technological progress and innovation in medium technology industries and it can be better explained as a set of different capabilities, rather than as a stock or a residual with respect to

codified knowledge. Among these capabilities, the role of knowledge integration has been argued to be of particular importance. A typology of local networks is developed and related to the different characteristics of the knowledge creation process. Thus, knowledge diffusion is not the result of automatic knowledge spill-overs, even at the local level, while its growth, diffusion and exploitation requires the development of adequate organizational structures and public policies, in order to sustain and embody individual and collective competencies of various kinds. In this framework, territorial knowledge management may represent an useful tool for analysis and policy making in different types of regional innovation systems.

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ABSTRACT

The characteristics and factors of interdependence and cooperation in innovation between firms in medium tech sectors are rather different from those within firms in high tech sectors. Knowledge creation has an interactive and combinative nature and the flows of knowledge and information lead – both from a positive and a normative perspective – to the development of complex learning and innovation networks. Spatial factors have an important role in the process of knowledge creation and agglomeration economies may be the results of the spatial nature of the cognitive processes. Tacit knowledge represents a key feature of technological progress and innovation in medium technology industries and it can be better explained as a set of different capabilities, rather than as a stock or a residual with respect to codified knowledge. Among these capabilities, the role of knowledge integration has been argued to be of particular importance. A typology of local networks is developed and related to the different characteristics of the knowledge creation process. Thus, knowledge diffusion is not the result of automatic knowledge spill-overs, even at the local level, while its growth, diffusion and exploitation requires the development of adequate organizational structures and public policies, in order to sustain and embody individual and collective competencies of various kinds. In this framework, territorial knowledge management may represent an useful tool for analysis and policy making in different types of regional innovation systems.