SIXTH FRAMEWORK PROGRAMME

IKINET
INTERNATIONAL KNOWLEDGE AND INNOVATION NETWORKS FOR EUROPEAN INTEGRATION, COHESION AND ENLARGEMENT

"Regional learning networks

in medium tech technologies and European integration"

Riccardo Cappellin* and Luigi Orsenigo**
* University of Rome "Tor Vergata"
** University of Brescia

FOURTH SCIENTIFIC WORKSHOP
February 23-25, 2006

Centre for Advanced Studies, Cardiff University,
Room 1.17, 44-45 Park Place, Cardiff, UK

Content

1. The contribution of **cognitive economics**
2. **Integrative capabilities**
3. The complex nature of **tacit knowledge**
4. **The territorial dimension of knowledge creation**
5. Key components of **knowledge and innovation networks**
6. The relations between the **network model** and the factors and **process of interactive learning**
7. **Network analysis** and **integrative capabilities**
8. The **different nature of networks**
9. Developing interactive learning processes through **Territorial Knowledge Management**
10. The role of **network concept** in **Territorial Knowledge Management**
11. The characteristics of **learning within "learning networks"**

Fundamental questions

a) Investigate both the territorial dimension of the cognitive processes and the cognitive dimension of the agglomeration economies

b) How the processes of knowledge integration and of interactive learning between various firms and sectors occur in the clusters made by SMEs specialized in medium technology sectors ?

c) Define different types of tacit knowledge and indicate how tacit knowledge circulate at the local level

d) Do the concepts used in explaining knowledge creation in cognitive economics have a spatial dimension ?

e) Does the network model be capable to illustrate in a formal way key concepts of cognitive economics and which are the key factors of learning processes within “leaning networks” ?

f) Define a typology of networks based on the characteristics of cognitive processes

g) Which is the role to be played by regional and urban governments in the diffusion of the knowledge economy and which instruments may be used at the regional level to promote a better integration of knowledge and innovation networks ?

h) Does the cognitive (technological) distance and the institutional distance play a greater role than the physical or geographical distance in hindering the cognitive relationships between economic lagging regions and the most developed regions at the European level ?

The contribution of cognitive economics

According to a cognitive perspective, the creation of a scientific breakthrough or an innovation may be analysed as the result of a process of interactive learning and of knowledge accumulation.

Knowledge sciences (Rizzello, 1999) show that improvements in the human knowledge base are only possible when outside **stimuli** reach the individual's cognitive system and these stimuli are integrated and **processed within the cognitive system**. In fact, the models of neural networks indicates that the creation of knowledge is the result of an **adaptive learning or searching process**, which leads to **new synaptic connections of various nodes**.

First of all, 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 stimulus from outside to 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, a firm or actor 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).

This process of adaptation, reconversion 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 the 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 allows 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 be determined by a **too low accessibility** or by a **too low receptivity**. The accessibility is affected by the **existence of infrastructures and institutions** which may decrease the distance between any two nodes. On the other hand, the 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 adapt gradually to it.

In particular, **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 a physical proximity, like also contacts through the ICT on long distance.

The process of learning does not occur through accumulation of knowledge within the firms in isolation, as innovation processes are tightly related to interactive learning processes and to the various forms of co-operation within **the networks made by firms and many other actors** (Cappellin, 2003a). Technological change is based on the 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 is viewed in a new perspective.

While the **concepts of combination and integration capabilities** are well established in the **literature on cognitive economics**, it is rather new in the **literature on innovation economics**, which has tradionally followed a "linear approach".

Cognitive economics considers the relevance for economics of human cognitive aspects
economics implies choices.
a choice is the result of psycho-neurobiological acts.

Neurognosis
preexisting neuronal structures
protection of the internal integrity
resistance to changes

Exaptation
adopting changes
negative feedback
environmental adaptation
individual cognitive maps evolve
classifying new external stimuli in preexisting nets
pathdependence
selfregulation (autopoiesis)

Principle of increasing entropy
timeirreversible systems are non-equilibrium open thermodynamics ch
Prigogin's dissipative structures
"are able to achieve a degree of 'selforganization' (or autopoiesis)
time-irreversibility, change is not linear and novelty matter

Idiosyncratic interpretation of external information
human genetic features
historical accidents
previous experiences
successful feed-back processes

Feedback and path-dependence
interpretation or classifications of external stimuli
success, reliability of classifications
experience
evolution of innate neurobiological perceiving structures,
creation of new neuronal structures
increases the resistance to change

Hayek's conception of the mind
Rules, routines, institutions
Saving the limited cognitive capacity
The evolution of the mind
psycho-neurobiological concept of evolution

The evolution of the mind
redesign the neuronal circuitries
balance between stable and unstable circuitries

Institutional economics
the evolution of the mind and the evolution of institutions
neurognosis, exaptation and path-dependence,
common culture, history paths

Cognitive economics, path dependency and institutions

Integrative capabilities (L.O.)

• 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**

• Strategic importance of integrative capabilities in explaining innovativeness.

• In knowledge intensive environments, there is the need to **reconcile apparently conflicting objectives**:

– **need to specialize** in order to be able to deepen competencies in existing bodies of knowledge and practice.

– **need to be able to combine, or integrate**, such specialized skills to be able to deliver new products and services. Hence, the increasing attention devoted to the analysis of knowledge integration (Grant, 1996); combinative capabilities (Kogut and Zander, 1992); architectural knowledge (Henderson, 1992); systems integration (Prencipe, 1997).

• Such **emphasis on 'integration' and 'combination'** highlight the fact that knowledge accumulation processes ought to be seen as **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, as empirical evidence shows that, for example, **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).

• **Firms with higher integrative capabilities are supposedly more successful.** For example, Nesta (2004) and Nesta and Saviotti (2004) found that, in the pharmaceutical industry, the extent to which heterogeneous technological fields are coherent, or integrated, has a positive impact on firms' market value. That is to say, markets value not knowledge accumulation *per se*, but the abilities of firms to make specialized knowledge coherent.

The complex nature of tacit knowledge

Tacit knowledge may be represented by **various competencies, which are localized or idiosyncratic and can not easily be transferred.** Tacit knowledge may refer to competencies, which characterize **how each actor behave or how he interacts with the other actors,** such as**:**

a) Tacit knowledge and the behaviours of the individual actor:

- receptivity or capability of patternmaking:
actors select and interpret "weak information" or "insider information", which may not be identified or understood by persons, who do not have cumulated adequate **experience and knowledge of the state of the art in a specific field**. They are capable to assign to these information a specific meaning and adapt this knowledge to a specific context. Firms may share a common **cognitive frame or common conceptions and an idiosyncratic knowledge,** which teach to the various firms belonging to the cluster, how to look at things from a different perspective.

- attitude to risk taking:
characteristics, such optimism, entrepreneurship and forward looking, are tacit, although they may be affected by past experience.

- creativity:
actors combine different fragments of existing knowledge, models or technologies in an **original or creative way,** in order to solve a specific or local problem. That capability is tacit, since **what has not been thought cannot be codified**.

- capability to learn:
learn to learn is the result of **the creation of new routines and heuristic procedures**, which make an actor to **combine "exploration" with "exploitation". Evolution and survival is the result of a learning process**.

b) Tacit knowledge and the interaction between different actors:

- automatic coordination:
actors are capable to coordinate their action with that of other actors, since **they react to external stimula in an automatic way** according to specific "routines", which have been interiorized, have often not explicitly codified and are only based on experience.

- learn together:
through **interactive learning processes** and by building new connections, **actors learn how to learn together with other actors** and **they jointly modify the rules of the learning process** and the common schemes of interpretation of external information.

- reputation and leadership/governance capabilities:
tacit knowledge may be represented by the implicit **esteem and thrust,** that an individual firm or entrepreneur enjoys in the local business community. Moreover, the **organizational and managerial capability to govern or steer** the action of other actors is **more an art that codified knowledge.**

Tacit knowledge, for its higher ambiguity and flexibility **than codified knowledge, plays a key role in knowledge creation, as it is more suitable for the combination of knowledge from different sectors, disciplines and countries. While** codified knowledge can be more easily transferred at distance**, it is more difficult to combine than tacit knowledge, which represents a key factor in the creation of new knowledge.**

The role of tacit knowledge, informal research processes and competencies

The distinction between **codified and tacit knowledge** can be combined with the distinction between the **formal research activities and the informal search activities** and also the distinction between the **development of innovation/inventions** and the **development of internal competencies** within the firms.

Innovation processes especially 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 non formalized search activities based on interactive learning processes within networks of firms.

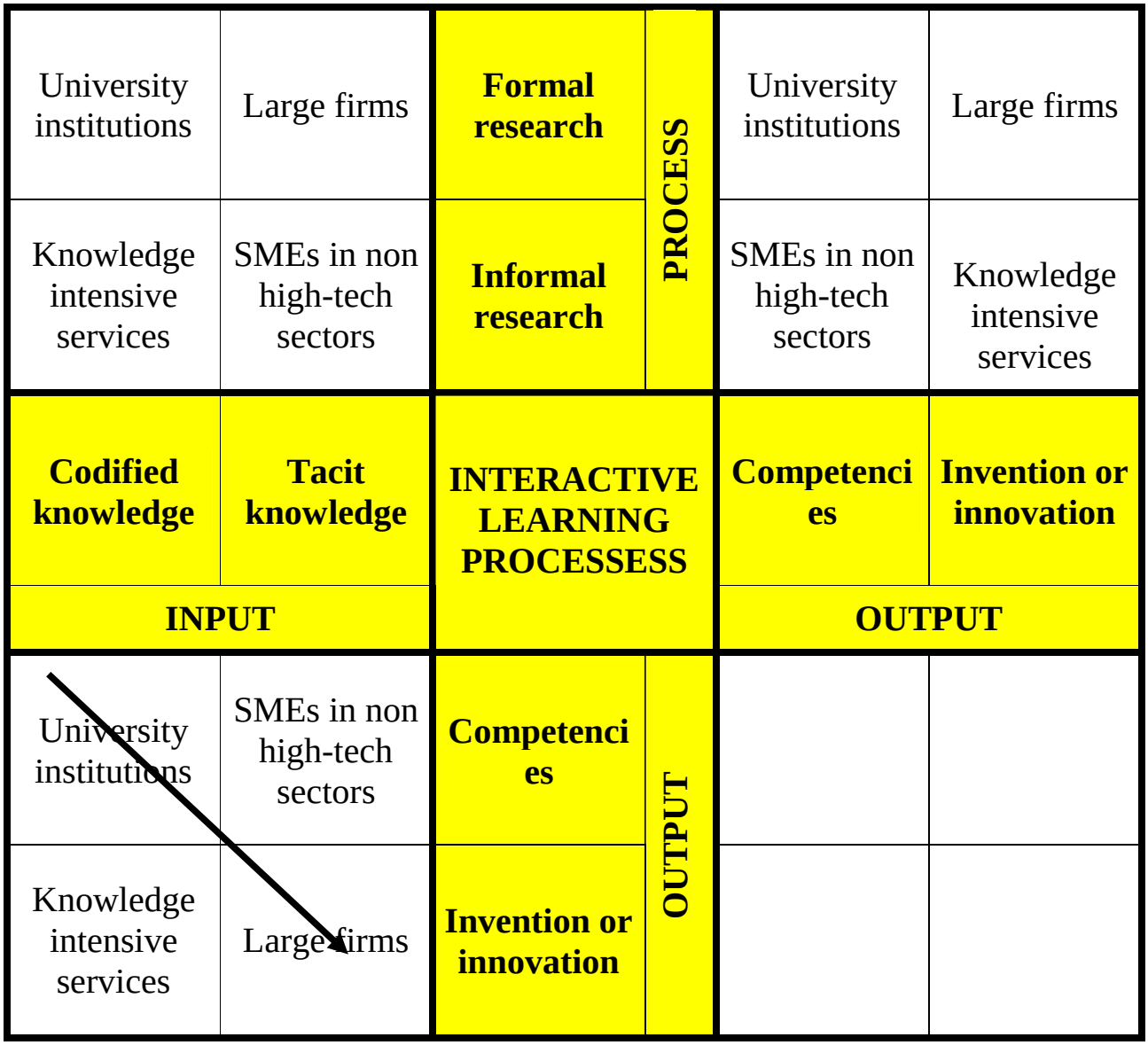
In particular, as indicated in table 2, innovation process can be characterized by specific forms of combination between different inputs, processes and outputs (Cappellin, 2004):

1. The development of interactive learning processes in the **traditional sectors where the SMEs are dominant** is characterized by: tacit knowledge, informal research processes and development of competencies.

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

3. the development of interactive learning processes in the **large firms** is characterized by: tacit knowledge, formal research activities and development of inventions/innovations;

4. the development of interactive learning processes in the **modern knowledge intensive services** is related to: codified knowledge, informal research activities and development of inventions/innovations.



Source: R. Cappellin, IKINET - International Knowledge and Innovation Networks, Research for the FP6, University of Rome "Tor Vergata", November 2004

Figure 1: The relationship between:
a) types of knowledge,
b) types of research processes,
c) development of competencies,
d) invention and innovation within the interactive learning processes

The local nature of learning: geography (L.O.)

• There some also broad – but still quite generic – analogies between the cognitive analysis of learning process and the analysis of innovation in specific geographical areas

• Much of the literature on innovative and productive clusters emphasises that the local dimension of learning is related to the transmission of tacit, specific knowledge

• Often, and especially in the econometric literature, this notion is operationalised through the concept of knowledge spillovers

• These channels and networks, whatever their specific nature, have always a deep organisational and cognitive structure

• It is important to study in much more detail the specific structure of these networks, which differ among technologies and local areas

The territorial dimension of knowledge creation

The industrial economists' starting point is the consideration of so-called "intra- firm" determinants of innovation (Capello and Faggian 2005)**.** Among these determinants a crucial role is played by **firm size and R&D expenditure**, both internal and external to the firm. Empirical analyses led in the past to some contrasting results, underlining some limitations of this approach and **the need for introducing other variables which are vital in fostering the innovation process.** Both large and small firms can proved to be very innovative due to certain **factors, which are completely exogenous to the firm itself, such as their sector and location**. As Geroski (1995) underlines, the **proximity to other firms** can be essential in increasing the innovation capacity of a firm, independently of internal firm characteristics.

Audretsch and Vivarelli (1996), for instance, try to measure the effect of knowledge spillovers on innovation – measured in terms of new patents (using data on Italian firms) - and they find a significant effect of these spillovers on small and medium sized firms. **The definition they use of spillovers, though, is not very wide, including only the physical proximity (physical distance) to universities or research centres**. Autant-Bernard (1999) extends the definition of spillovers to include also the **proximity of a high number of firms belonging to the same sector**.

There is agreement on the fact that **"knowledge spillovers" among firms located in close proximity to each other play a crucial role** in improving the innovative capacity of firms, **but industrial economists have some difficulty in clearly defining these knowledge spillovers.** They remain a vague concept, a sort of "black box", the content of which is not known.

In the industrial economic view, space is a pure physical variable, while regional economists perceive space in a more complex way. **Physical space is coupled with "relational" space, made by all the different relationships built among local actors.** The well-known concept of "milieu innovateur" refers to this more complex concept of space **(**Capello and Faggian 2005).

In the industrial approach, there is no clear definition of the channels through which physic al proximity materialises into geographical knowledge spillovers (from now on simply GKS). All that is known is that the proximity to other firms or research centres positively influences the performance and the innovativity of a firm, but it is not clear how this happens. **Everything is due to pure probabilistic mechanisms.**

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

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.

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

The local nature of learning: cognition (L.O.)

• A complex and variegated debate

• Learning is often local, from the cognitive point of view: learning occurs cumulatively, looking first in the neighborhood of what is now known (from Rosenberg to P. David)

• But learning entails also big jumps, access and absorption of “distant” knowledge, reconfiguration of problems and knowledge structures

• Much of the literature on innovative and productive clusters emphasises that the local dimension of learning is related to the transmission of tacit, specific knowledge

• Often, and especially in the econometric literature, this notion is operationalised through the concept of knowledge spillovers

The spatial dimension of the cognitive processes

The nature of the process of knowledge creation within the literature of cognitive economics is apparently a-spatial. However, this literature illustrates that it has a combinative and an interactive character. Thus, it may be indicated 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.**

- **The stimulus to innovate:**

The local environment and the **aim to solve the problems of local users** is important in providing a **stimulus to innovate to the various firms**. 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**.

- **The receptivity to innovation:**

On the other hand, external stimulus should be compatibles with **the internal integrity ("neurognosis") of the local production system** and 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.

- **The process of exploration:**

The process of **search of innovative solutions is constrained by cognitive proximity** and it usually occurs first of all through the analysis of the complementary resources existing at the local level. A low cognitive distance explains the importance of client–supplier relationships in the process of innovation and co-makership.

- **An higher diversity and lower transaction costs:**

As knowledge creation requires the combination or use of various complementary resources the **concentration of firms in large metropolitan areas** (Cappellin 2000) **or local industrial clusters** (Steiner, 1998) facilitate innovation both because it **decreases the transaction costs** between the actors and because it enhance the business opportunities and facilitate 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.

- **The path of evolution and lock-in effects:**

Knowledge creation is tightly **related to the sectoral specialization, the industrial culture and know-how** existing in the innovation systems to be considered. That facilitates the early identification or the design of new patterns, combining previously existing ideas and pieces of information and knowledge. It also **constrains the discovery of new pattern** in the attempt to insure the consistency and compatibility with existing solutions and that **leads to path-depency and in some case to "lock-in" effects**.

- **Common culture, identity and social capital:**

The local history and memory, such archaeology vestiges, which are the result of centuries of interdependence between the local actors, are a distinctive characteristic of the individual places. **Common history leads to common cultures, patterns and vision of the future and reciprocal trust**, as also to the creation of local institutions and routines, which represent the **local "social capital"** (Maskell 1999) and facilitate the connections and decrease the cognitive distance between the local actors.

Three perspectives in the analysis of networks:

A modern industrial economy can be defined as a "complex adaptive system" which is similar to a cybernetic circuit performing various calculations or to a network of biological cells, which leave together in a relationship of symbiosis.

- **the market**: both demand and supply in the neoclassical economics approach of equilibrium are made by homogenous goods and actors, which are perfectly mobile,

- **the electronic circuit** implies feedback effects between stable nodes and no distance cost between nodes,

- **the bio-systems:** while the nodes in e-networks are fixed, in bio-networks there is an **high turnover of actors** due to the deaths and births (i.e. spin-offs or mergers of firms). Moreover, while the **distance between nodes** is not important in e-networks, it is relevant in bio-network, where the relationships between nodes are affected by the existence of intermediaries, catalysts, differences in the characteristics of the various nodes and their level of receptivity.

A complex adaptive system (Holland, 2002)**,** is made by different social or biological units subject to combination and selection processes and having different and complementary characteristics.

This has lead to an innovation model which is different form the **"linear model",** based on the evolution from the basic research, the applied research, to innovation and technology transfer and which may be defined as the **"systemic model"** based on the interdependence between the development of knowledge and their application to the production processes and the integration between various actors.

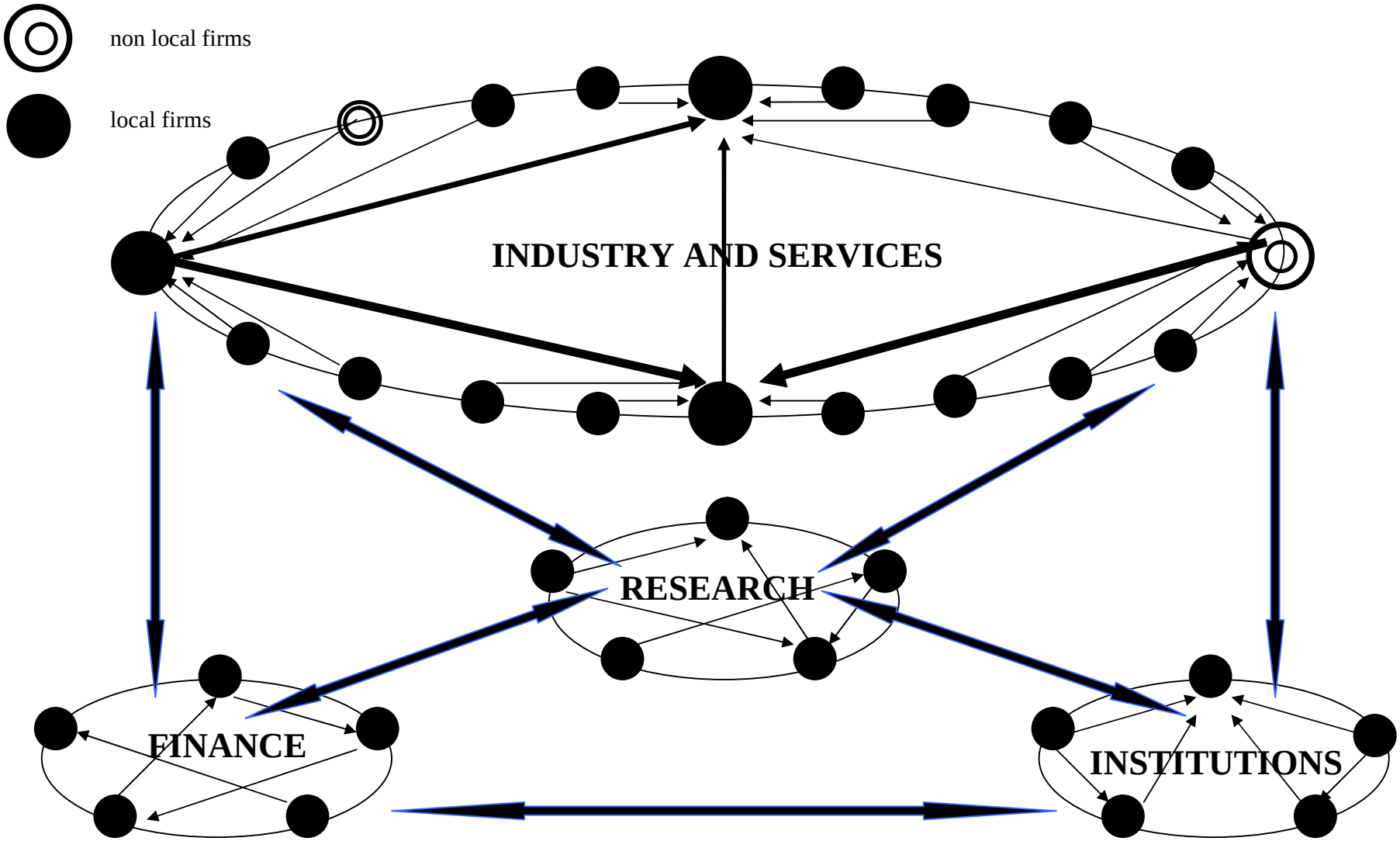


Fig. 2 - The network of links in a national / regional innovation system

Source: R. Cappellin, IKINET - International Knowledge and Innovation Networks, Research for the FP6, University of Rome "Tor Vergata", November 2004

Key components of knowledge and innovation networks:

- **the 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,

- **the 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,

- **the distance,** 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 determinats are the differences in the characteristics of the various nodes.

- **the 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".

A network perspective in the analysis of the learning process emphasizes the importance of the analysis of the structure of the direct and indirect links, the distance and the infrastructures between the actors.

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.

The analysis of changes in knowledge networks

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,** as they may increase or decrease,

- **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.

The process of knowledge creation within networks

"Network externalities" may be expressed by Metcalfe's Law according to which the more individuals, institutions and organisations participate in a network, the higher is its economic value and its innovation capacity.

The base of competitiveness and of survival in the knowledge economy is the diversity and the cooperation between the various nodes in the knowledge networks. In fact, a knowledge economy **should enhance the diversity of knowledge and competencies, since they allow to exploit complementarities and develop various forms of cooperation**.

The learning and knowledge creation process has an interactive and combinatory characteristic, since it requires the synergy or integration between various abstract building blocks as also of various economic actors with different, specialized and complementary knowledge and competencies.

Learning and innovation are collective and interactive processes, which require the access, interaction, integration of heterogeneous actors, capabilities and technical competencies and of **complementary fragments of knowledge and information**.

The process of creation of knowledge **can not be based on a rational process of optimization of the links between cognitive blocks**, but rather on an informal and continuous exploration, based on trial and error attempts and search for explanation of previous failures.

Innovation has a systemic, organizational and often territorial nature, as it implies the collaboration and integration of a variety of differentiated actors according to different forms and intensity.

Technological change presents two important characteristics (Cappellin, 2003):

- it has **an interactive dimension** or it is based on interactive learning processes,

- it has **a combinative character** or it is based on the original connection of concepts and elements, which may even be already known but where previously disjoint between themselves.

Thus, learning and knowledge creation processes are driven and facilitated by the **existence of networks** and **relationships between various networks.**

Knowledge creation and innovation are related to:

- **the intensity of the interaction** between the various nodes of a network or the intensity of the existing direct links,

- **the speed of change of the links** between the various nodes of a network through the creation of new direct links and also of new nodes.

Technological change in a network perspective is determined by the **continuous and incremental search of different types of relations** between the various nodes, **searching for a more appropriate forms of integration**.

Network analysis and integrative capabilities **(L.O.)**

• A growing literature on networks focuses not only on network structural characteristics (e.g. centrality, density, connectedeness, ties strength etc.) but also on 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:
  – successful product and process innovations require *champions* (Allen, 1977; Roberts 1987; Rothwell, 1990).
  – 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. For example, some authors discuss technology 'brokers', who recognize, store, blend, and transform technologies (Hargadon and Sutton, 1997).

Brusoni et al. (2001) talk about 'integrators' which coordinate loosely coupled networks of specialized suppliers. However, little is 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, if at all, and how such differences impact on networks' evolution and performance is unclear.

The different nature of networks

Networks may have different characteristics and they may be distinguished in the following three types (Cappellin 2003b):

- **'Ecology networks'**, often indicated as 'agglomeration economies' or as 'complex adaptive systems' and characterised by strong interaction. Ecology networks are **made by relationships of objectively observable stable interdependence or integration**. 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 characterize the areas of concentration of the firms belonging to the same sector or the urban areas. 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 casual 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. That 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 and of common institutions and specialised intermediate social organisations, which are defined as "social capital" (Coleman 1988). These networks are places of collective learning and 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 on negotiations, the agreement 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”.

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 keeping the regional competitiveness (Maillat and Kebir., 1999)

The objective of a ‘learning region’ is that of integrating tacit or implicit traditional knowledge, which is bound to 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 undergoes an ongoing evolution thanks to the active role of the processes of learning, adaptation and innovation.

Developing interactive learning processes through Territorial Knowledge Management

Regional innovation policies should design appropriate methodologies in order to promote the creation of a "learning region" and to well organize the cognitive relations between the various local firms and actors, which represent a key advantage of agglomeration economies.

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).

In particular, TKM 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) to **extract the value of Territorial Knowledge Capital** through the enhancement of innovation which represents the key factor for the competitiveness and growth of a regional economy;

c) to **create new innovation networks** within the regional innovation system and 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**.

Regional **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 knowledge 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.

Territorial Knowledge Management 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, through which the firms and the actors in a traditional production system circulate the required information and competencies among them in a too implicit, complex and slow process.

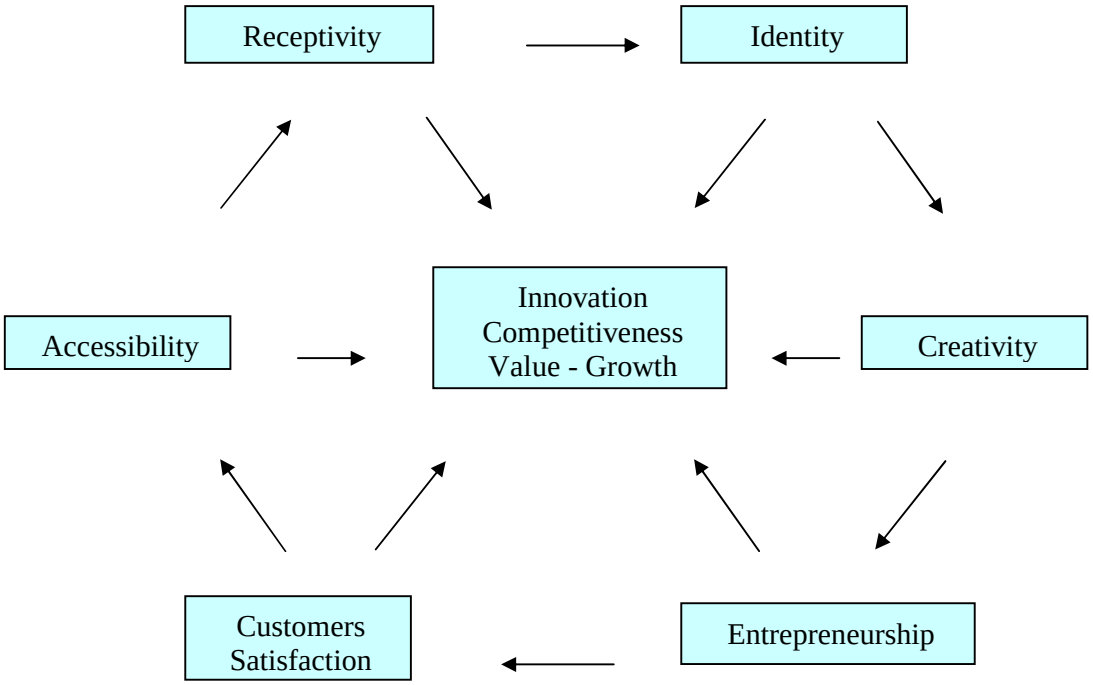


Figure 3 - The six perspectives of Territorial Knowledge Management

In particular, according to **the approach of Territorial Knowledge Management** (Cappellin , 2003b) there are six factors 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

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 the 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 tacit factors, which represent the conditions for the socialization of tacit knowledge within the groups, firms and organization.

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 that they become capable to acknowledge the need of complementary external knowledge and to assimilate it. The capability to interact of the various actors to be involved in an innovation process may be considered as a form of tacit knowledge and it is hindered by the cognitive distance determined by differences in the education level, cultural background, but also the different sectoral or technological specialization, the lack of broad diversified experiences and a too low capability of learning. The availability of **tacit knowledge** by the individual actors represents the base for the development of interactive learning processes. Education enhance receptivity and it is about the 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 to be involved in innovation should share common aims, mental models, as also trust and loyalty. To promote knowledge sharing and the willingness to collaborate requires a change in the corporate culture. The identification of common challenges to survival and development create a sense of belonging to the same community or group and are a prerequisite for collaboration in innovation. Collaborative attitudes by the 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 or just common agreed routines, which are part of the "social capital" of the regional economy considered. 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 the capability to establish original contacts or synapsis 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 to be involved in the innovation process and the exploitation of their idiosyncratic characteristics. In particular, to increase creativity firms should aim to leverage morale and to the 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. The process to combine in an original way existing knowledge **is necessarily tacit**, as what has not yet been thought cannot yet be codified.

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. That requires entrepreneurship capabilities and to integrate knowledge with complementary material resources, in order to transform knowledge into action. The adoption of innovation requires the 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. Clearly, **tacit factors** are also relevant in this phase of the process of knowledge creation and of interactive learning, since the organizational and managerial capability to govern or steer the action of other actors is more an art that codified knowledge.

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 as also for the development of their sense of belonging.

Learning networks: the cognitive dimensions of the network model

The approach of Territorial Knowledge Management leads to identify the relationships between the **network model approach** and the process of knowledge creation and of interactive learning. Therefore, **"learning networks"** are characterized by the following relationships.

- The **concept of customer orientation** may be measured by the links between the nodes and other nodes which represent the markets for the production considered.

- **The concept of receptivity** may be measured by the internal characteristics of each individual node within a network.

- **The concept of accessibility** may be measured by the distance between the various nodes.

- **The concept of identity** may be measured by the existence of institutional infrastructures facilitating the interaction between the nodes.

- **The concept of creativity** may be measured by the capability to recombine the information and to and rearrange the direct and indirect links between the nodes.

- Finally, **the concept of governance** may be measured by the various measures agreed within the "policy network" made by the various relevant stakeholders.

Networks not only increase the efficiency of local resources, but also enhance the growth of local resources and ensure the sustainability of the local development process.

Regional learning networks in medium tech technologies and European integration

Riccardo Cappellin
University of Rome "Tor Vergata"
Department of Economics and Institutions
cappellin@economia.uniroma2.it

The paper aims at investigating the transfer of tacit knowledge both at the regional and at the interregional level and it focuses on the factors and forms of the processes of interactive learning between small and medium size in medium technology sectors.

The analysis proceeds from the contributions of four strands of literature, focusing on **economics of agglomeration**, **cognitive economics**, industrial strategic alliances and governance in a knowledge economy.

While industrial economics interprets technology spill-over at the local level as an automatic and chaotic process allowed by geographical proximity of the firms, **regional economics** identifies different specific types of flows and networks, which link together in an organized way the various firms and other private and public actors within a given regional innovation system.

Cognitive economics may bring a significant contribution, as it considers the relevance for economics of human cognitive aspects and it discovers the key role in the creation of new ideas of selected factors, such as the stimulus by changes in the external environment, the process of "neurognosis" or negative reaction aiming to the protection of the internal integrity, the search process constrained by cognitive proximity, the success in pattern making and the achievement of consistency and compatability, the process of "exaptation" or reconversion leading to path-dependency, the creation of new connections and routines and institutions, which allows to save the limited cognitive capacity of individuals and organizations.

This theoretical framework in the analysis of the processes of knowledge creation may be schematically represented through the model of **"Territorial Knowledge Management",** which aims at promoting the interactive learning processes within the regional innovation systems and focuses on a selected list of knowledge levers, such as: market orientation, accessibility, receptiveness, common identity, creativity and governance.

On the base of these theoretical concepts and tools, the paper analyses various case studies of firms embedded in different industrial clusters in Europe, focusing on the forms of the process of interactive learning and innovation between the various regional actors.

Finally, the paper attempts to derive from that analysis useful indications for the possible extension of knowledge and innovation networks at the interregional and international level and for decreasing the regional divide in a modern knowledge economy.

The research has been undertaken within the framework of the project: “IKINET – International Knowledge and Innovation Network” (EU FP6, N° CIT2-CT-2004-506242).

Keywords: knowledge creation, interactive learning processes, industrial clusters, innovation policies, European integration, intermediate technology sectors, small and medium size firms.

SECTIONS TO BE EVENTUALLY INCLUDED IN THE FINAL PAPER

The local nature of learning: firms

• Increasing recognition of the importance to link strictly the analysis of cognition to the analysis of organisational structures where learning occurs

• This is at the heart of the “competence based” theory of the firm: from Simon and March to Nelson and Winter and much beyond this

Basic trade-offs and organisational dilemmas

• Learning always entails intrinsic dilemmas and related organisational solutions:

• exploration and exploitation

• integration and coordination vs. specialization and decentralization

• capabilities of exploration

• Absorptive capacities

• Integrative capacities

Knowledge brokers and knowledge integrators

• Yet, 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
- knowledge integration proper.

Intuitively, it is relatively easy to distinguish brokers from integrators:

• Brokering: 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 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 a higher level of understanding of the activity of others than brokerage.

• Knowledge integration involves the ability to act upon and modify the contribution of others in order to identify and manage interdependencies and critical issues.

• However, it much more difficult to develop more precise theoretical definitions of these concepts, let alone empirical measures.

• What is the relative role of knowledge brokers and knowledge integrators? • How can brokers and integrators be more precisley defined and identified empirically? • What the relationships between brokerage, integration and performance?

The role of technology platforms in knowledge and innovation networks

Innovation platforms should **focus on industrial projects** which may give results in a short or medium term and are different from “centres of excellence” focused in base research. They should link together the applied research of research institutions and the industrial research of private firms.

Innovation platforms can aim to **promote innovation** in existing firms or to **create new innovative firms**.

An innovation platform can **include various firms (30-60)**, both industrial and service firms, of large and small size, national and international focused on knowledge and oriented to innovation

Innovation platforms **represent a partnership between different organizations and institutions**, such as **private firms**, **research organizations**, technology centres, universities, industrial associations, national and local **public institutions** and specialized **credit and venture capital companies**.

Innovation platforms are usually **part of a regional or national network** and may have **different legal form**.

References

Antonelli, C. (2005), Models of knowledge and systems of governance, Department of Economics "Cognetti de Martiis", Università di Torino, Working paper No. 01/2005.

Capello, R.; Faggian, A. (2005): Collective learning and relational capital in local innovation processes, Regional Studies, 39, 75-87.

Cappellin, R. (2000), Urban agglomeration and regional development policies in an enlarged Europe, in Bröcker J.and Herrmann H., eds, Spatial Change and Interregional Flows in the Integrating Europe - Essays in Honour of Karin Peschel, Physica-Verlag, Heidelberg.

Cappellin, R. (2003a), Networks and Technological Change in Regional Clusters in Bröcker, J., Dohse, D. and Soltwedel, R. (eds.), Innovation Clusters and Interregional Competition, Springer Verlag, Heidelberg, 2003.

Cappellin, R. (2003b), Territorial knowledge management: towards a metrics of the cognitive dimension of agglomeration economies, International Journal of Technology Management, Vol. X, n. X.

Cappellin, R. and L. Orsenigo (2000), The territorial dimension of modern industry and the scope of regional industrial and labour market policies, in Klemmer, P. and R. Wink (ed.), Preventing unemployment in Europe. A new framework for labour market policy. Elgar, Cheltenham, UK, Northampton, US, pp.166-187.

Coleman, J.S. (1988), Social capital in the creation of human capital, American Journal of Sociology, Supplement, Vol. 94: 95-120.

Gould, S. J. (1991) 'Exaptation: a crucial tool for an evolutionary psychology', Journal of Social Issues, 47 (3): 43–65.

Hayek, F. A. (1937), 'Economics and Knowledge', Economica, n.s. IV, n. 13: 96-105.

Holland, J.H (2002), Complex adaptive systems and spontaneous emergence, in Quadrio Curzio, A. and Fortis, M. (eds.), Complexity and industrial clusters: dynamics and models in theory and practice, Heidelberg, Phisica-Verlag: 25-34.

Laughlin, C. (1996) 'The properties of neurognosis', Journal of Social and Evolutionary Systems, 19 (4): 363 – 380.

Loasby, B. J. (2003), Organisation and the human mind, Department of Economics, University of Stirling, Scotland.

Maillat, D. and Kebir. L. (1999), "Learning region" et systemes territoriaux de production, Revue d'Economie Regionale et Urbaine, n. 3: 430-448.

Maskell, P. (1999), Social Capital, Innovation, and Competitiveness. In: Baron, S., Schuller, T. (Eds.), Social Capital. Critical Perspectives. Oxford University Press, Oxford, pp. 111–123.

Nonaka, I. and Konno, N. (1998), The concept of “Ba”: building a foundation for knowledge creation, California Management Review, 40, 3: 40-54.

Rizzello, S. (1999), The economics of the mind, Aldershot, E. Elgar.

Rizzello, S. (2003), Towards a Cognitive Evolutionary Economics, Centro di Studi sulla Storia e i Metodi dell’Economia Politica "Claudio Napoleoni" (CESMEP), Università di Torino, Working paper No. 03/2003.

Steiner, M. (1998), The discret charm of clusters: an introduction, in Steiner, M. (ed.), From agglomeration economies to innovative clusters, London, Pion, European Research in Regional Science.