Keynote Speech

The European Economic Space: the Governance of Industrial and Knowledge Networks in Medium Technology Sectors

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The model of the "knowledge economy" has become a paradigmatic framework in Europe within which a proposal of new industrial and economic development policy can be designed. However, the concept of the "knowledge economy" appears as rather loose. In this perspective it seems useful to underline the difference between this concept and other related concepts, such as:

- high tech or R&D intensive industries,
- information and communication technologies,
- new technologies, biotechnologies and nanotechnologies,
- human capital and education levels,
- knowledge intensive services,
- intangible assets and intellectual capital.

Usually, the concepts of the "knowledge economy" are used in order to indicate a development phase where the scientific knowledge and human resources represent the strategic factors. In this study, the concept of knowledge economy is identified with that of the "learning economy" and the analysis is focused on the link between the processes of learning, innovation and competitiveness.

In a knowledge economy the competitiveness of the firms is determined by the quality of the products and processes, the decrease of decision, production and delivery times of new products, the adoption of technological and organizational innovation in production

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processes. It is crucial to develop the competencies and professional skills of the labour force, the intermediate and top managers. The factor which determines the survival and success of firms are increasingly less the fixed investment and the financial resources and more the know-how, the intangible resources and the distinctive competencies.

This contribution aims, first of all, to illustrate the importance of medium and low technology products in international trade and the competition between the three world large economic regions.

Secondly, it illustrates the process of innovation, knowledge creation and interactive learning, which characterizes national and regional innovation systems specialized in medium and low technology sectors, and the structural characteristics of knowledge and innovation networks[1].

Thirdly, it illustrates the model of multi-level governance as the most appropriate method for promoting the processes of systemic innovation, both in the high technology sectors and in the medium and low technology sectors, by facilitating the integration of the various actors and firms within interactive learning processes.

In general, this contribution aims to illustrate that the processes of innovation in the medium and low technology sectors are different from those in the high technology sectors, as they are not based on high investments in R&D but rather on the importance of interactive learning processes, informal research activities and the development of tacit competencies of integration.

It also aims to highlight that an high international competitiveness of economies specialized in medium technology industrial sectors requires the steering of knowledge and innovation networks within the national and regional innovation systems and a new policy making approach which may be defined as the process multi-level governance and is different not only from the traditional hierarchical planning approach but also from pure competition as in the free market model.

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1 The International Specialization in the Medium Technology Sectors

According to OECD statistics the share of medium technology trade is not only more than half of the total trade in OECD countries, but it has also been rather stable in the last ten years, as the growth of high technology sectors has occurred at the expenses of low technology sectors and not of medium technology sectors.

Table 1 **Structure of OECD manufacturing trade by technology intensity (share in total manufacturing trade)**

	High technology	Medium-high technology	Medium-low technology	Low technology
1992	19.7	38.9	16.5	24.9
1993	20.6	38.4	16.2	24.7
1994	20.9	38.9	15.8	24.3
1995	21.2	39.1	16.0	23.6
1996	21.6	39.4	15.6	23.3
1997	22.7	39.2	15.4	22.6
1998	23.9	39.2	14.8	22.0
1999	25.1	39.2	14.1	21.5
2000	26.9	38.1	14.7	20.3
2001	26.1	38.3	14.7	20.8

Source: OECD, STI Scoreboard 2003 and STAN database, May 2003.

World trade may be analyzed by comparing individual countries, as the United States and the individual European countries, which clearly have a much minor size whether they are taken individually. Otherwise, it can be analyzed by considering large areas of economic integration. In this framework, Europe or the European Community can be compared to the North American economy (NAFTA). That requires subtracting the trade flows with the contiguous countries belonging to the same regional area. It results that the export from the NAFTA area (481 mld dollars) to the other world areas were in 2002 almost the half of the European exports (940 mld dollars)[2].

On the contrary, the imports of products from both areas (respectively 981 e 933 mld.) were almost equal between North America and Europe. Therefore, the low value of exports or the low competitiveness of American productions on the international markets

[2] *See WTO (2003a).*

are the fundamental reasons of the enormous deficit of the American trade balance, which increasingly appears as the most important dangerous factor of instability of the world economy (WTO, 2003a).

Often it is argued that a greater specialization in the high tech sectors is crucial in order not to loose share of international trade. This statement is rather general and need to be qualified. In fact, the analysis of the period 1992-2001 indicates that the growth rate of international trade has been very high in various sectors with intermediate technology (such as electrical machinery) and even in some low technology sectors (such as other manufacturing products)[3].

Moreover, the flows of ICT products have increased in the most recent years (2002) to a much lower pace than the other industrial products. That is clearly linked to the burst of the dot-com speculative bubble, determined by excessive investments in the ICT sectors and to the increasing role in the international trade of fast growing countries, such as China, which are determining higher trade flows in other products, such as raw materials and traditional industrial products.

The percentage of high tech sectors on total exports is an inappropriate indicator of innovative capability, since high values are indicated not only for Japan and US, but also for Mexico and Hungary, which overcome countries such as Sweden and Finland (OECD, 2003).

According to OECD, manufacturing sectors can be distinguished in high, medium-high, medium-low and low technology sectors on the base of their average ration of R&D expenditure on value added. In this framework, the ICT and pharmaceutical sectors, in which the US specialization is strong, are among those with high technology, while among the medium-high technology sectors are those in which traditionally European countries are specialized, such electrical machinery, automobile industry and chemical industry (OECD, 2003).

In this perspective, it may be useful to analyze on the base of the WTO data for the years 2000-2002 the network of world trade flows for some categories of product, which have been defined according to inclusive criteria and may be classified according to an increasing order of technological intensity, such as: a) total trade and within it: b)

[3] *See OECD (2003).*

manufacturing products, and within it: c) machinery and transport equipment, and within it: d) office and telecommunication equipments. Three areas may be considered: North America, which includes US and Canada, Western Europe and the rest of the World, which thus includes large countries such as Japan, China and the other Asian economies.

As it is well known the US are usually considered as the most technologically advanced economy of the world and various scoreboards elaborated by international organizations define the US as the most competitive economy. Therefore, the data of world trade should indicate that North America has a large positive trade balance especially in the most advanced sector, such as the "office and telecom equipments and then in the following order: the machinery and transport equipment, the manufactures non machinery and finally also for manufactures products.

In fact, it may be seen that North America has a deficit even in the office and telecom equipment sector and a greater and increasing deficit (-176) in the machinery and transport equipment. A slightly lower although increasing deficit (-163) appears in the manufactures non machinery sector and finally a very low and also decreasing deficit (-51) in the non manufacturing sectors such as agricultural and mining products[4].

Therefore, the specialization of North America economy is greater in the sectors with lower technological intensity, such as agricultural and mining products and it is decreasing in the more advanced sectors, such as machinery and transport equipment.

Similar indications may be derived from the analysis of the shares of individual products on the total exports of the individual areas and from the index of specialization in table 3 (world equal 100).

North America is characterized by a rather peculiar specialization. On the one hand it has a strong specialization in the agricultural and mining products and on the other it has a strong specialization in the machinery and transport equipment. Finally it had a positive specialization, later becoming negative, in the office and telecom equipment sector.

Therefore the specialization in the "high tech" sectors of North America is not the result of an absolute strength in these sector, as it would be in the case of a supposed greater competitiveness in these sectors, while it is the simple statistical result of the low overall exports of North America.

[4] *Our elaboration on WTO (2003b).*

In fact, North America has a negative trade balance, as indicated above, both on machinery and transport equipment and on office and telecom equipment and on the other hand also the exports of other sectors are low, such as in the case of manufactures non machinery, which indicate a very strong negative trade balance and a very low specialization index.

Therefore, the strong specialization of American export in the high technology sectors, on the one hand does not hinder the fact that North America has a high deficit in the high technology sectors and on the other hand it is due to the low value of the medium and low technology exports. In other terms, it is the results of an even weaker competitiveness of the medium and low technology sectors.

On the contrary, the European economy is characterized by a large positive and increasing trade balance in the machinery and transport equipment sector and by an even larger balance in the manufactures non machinery sector. Similar indications may be derived from the observation of the export shares and of the index of specialization of these two sectors. On the other hand, Western Europe is characterized by a large trade deficit in the agricultural and mining products sectors, where North America for simple geographical reasons is largely favoured.

Finally the Rest of the World, where Japan and the other Asian economies have a crucial role, is characterized by a positive trade balance in the office and telecom equipment sector and in the agricultural and mining products sectors. Similar indications may be derived from the analysis of the export shares of these sectors and by the index of specialization.

In conclusion:

- Western Europe is specialized in the manufactures products and in manufactures non machinery products,
- North America is specialized in the agricultural and mining products sectors and in the machinery and transport equipment sector,
- Rest of the World is specialized in agricultural and mining products sectors and in office and telecom equipment sector.

The specialization indexes do not change substantially in time. However, it is possible to observe that:

- North America despecializes from the office and telecom equipment and the machinery and transport equipment
- Western Europe despecializes from the agricultural and mining products and the office and telecom equipment,
- The Rest of the World specializes even more in the office and telecom equipment sector.

Table 2. **Trade balance for products with different technological intensity in three world areas**

	Total merchandise exports		Agriculture and mining		Manufactures		Manufactures non machinery		Machinery and transport equipment		Office and telecom	
	2000	2002	2000	2002	2000	2002	2000	2002	2000	2002	2000	2002
North America	-347	-390	-291	-51	-289	-339	-135	-163	-154	-176	-54	-62
Western Europe	4	109	-603	-111	125	220	75	115	50	105	-56	-65
Rest of the World	344	281	895	162	164	119	60	49	105	71	110	107

Source: WTO (2003b).

Table 3. **Share of exports by sector on total exports**

	World			North America			Western Europe			Rest of the World		
	2000	2001	2002	2000	2001	2002	2000	2001	2002	2000	2001	2002
Agricultural products	8.81	9.20	9.29	10.04	10.45	10.72	9.27	9.27	9.36	7.90	8.64	8.71
Mining products	13.85	13.17	12.56	7.19	7.51	7.16	7.74	7.25	6.89	22.14	21.29	20.11
Manufactures	74.83	74.97	75.06	77.98	77.04	76.91	80.77	81.27	80.70	68.08	67.87	68.80
Manufactures non machinery	32.96	33.88	34.58	28.46	29.17	29.76	38.66	39.16	40.08	29.42	30.47	30.81
Machinery and transport equipment	41.88	41.09	40.49	49.52	47.87	47.15	42.12	42.11	40.62	38.66	37.40	37.99
Office and telecom equipment	15.33	13.91	13.36	16.46	14.08	12.58	10.94	10.20	8.99	18.96	17.55	17.99
Residual	2.50	2.66	3.09	4.79	5.00	5.21	2.21	2.21	3.05	1.87	2.19	2.38
Total merchandise exports	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: WTO (2003b).

Table 4. **Index of specialization**

	World			North America			Western Europe			Rest of the World		
	2000	2001	2002	2000	2001	2002	2000	2001	2002	2000	2001	2002
Agricultural products	100	100	100	114	114	115	105	101	101	90	94	94
Minino products	100	100	100	52	57	57	56	55	55	160	162	160
Manufactures	100	100	100	104	103	102	108	108	108	91	91	92
Manufactures non machinery	100	100	100	86	86	86	117	116	116	89	90	89
Machinery and transport equipment	100	100	100	118	117	116	101	102	100	92	91	94
Office and telecom equipment	100	100	100	107	101	94	71	73	67	124	126	135
Residual	100	100	100	192	188	169	88	83	99	75	82	77

Source: WTO (2003b).

Table 5. **Share of export on import**

Total merchandise exports	**2000**	**2000**	**2000**
Share Export / import	**North America**	**Western Europe**	**Rest of the World**
North America	0	36.37	148.62
Western Europe	-26.67	0	118.46
Rest of the World	-59.78	-54.22	0
Total export/import	-41.31	-19.10	44.95
Total merchandise exports	**2002**	**2002**	**2002**
Share Export / import	**North America**	**Western Europe**	**Rest of the World**
North America	0	59.14	73.34
Western Europe	-37.16	0	-1.37
Rest of the World	-42.31	1.39	0
Total export/import	-29.19	4.26	11.79

(Percent ratio Export/import)
Source: WTO (2003b).

Therefore important factors are:

- the strong and increasing positive trade balance in Western Europe in the manufactures non machinery sector,
- the strong positive trade balance of the Rest of the World in the office and telecom equipment sector and the increasing specialization in this sector,
- the fact that the large specialization of North America in the machinery and transport equipment sector does not hinder that North America has a large and increasing negative trade balance in these sectors, as also in that of the manufactures non machinery sector.

In North America the share of high technology products on total exports is large mainly because the production and export capacity in the medium and low technology sector is low, due to the relocation of these productions toward the emerging countries.

In particular, a recent study by Business Week (2004) has analyzed about 300 companies, for which data are available[5] and are included within the roughly 700 non-U.S. companies that are part of the Standard & Poor's Global 1200. It indicated that the share of R&D and capital spending, as percentage of outlays[6], is larger in non US companies, mainly European and Japanese, than in the US companies for many and rather important industrial sectors, characterized by an intermediate technology, such as:

- Autos & Components
- Capital Goods
- Consumer Goods
- Food, Beverage, & Tobacco
- Household Products
- Materials

On the contrary, this study indicates that the share of R&D and capital spending is higher in the US companies only in the case of a limited number of so called "high tech" sectors, which as it is well known have been characterized by a sharp decline of shares and sales value in the last few years after the "new economy" bubble, such as:

- Drugs & Biotech
- Semiconductors
- Software & Services
- Technology Hardware

That demonstrates that the traditional distinction between "high tech" and "non high tech" sectors obscures the importance for a national economy to compete through a greater R&D and investment effort in many intermediate technology sectors, which play a major role in international trade.

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[5] *Fiscal years ended on or before June 30, 2004.*

[6] *Outlays consist of capital spending plus a broad measure of operating expenses, including R&D.*

Moreover, the greater importance of intermediate technology sectors in the European economies with respect to the US economy to a large extent explains also the different characteristics of the labour force in the two areas. In fact European countries indicate a much higher percentage of graduates in the engineering field of study on total graduates, of graduates in science and technology on total population and also a higher share of technicians on total employment. On the contrary, the greater importance of service activities in the US economy explains the higher share of professionals on total employment.

The enormous trade balance of United States is exemplified by the fact that the American exports toward Western Europe and the rest of the World have a value that is respectively lower by 37% and 42% than the imports from these areas.

It seems necessary to distinguish the US supremacy in the scientific field, which is undisputable and it is related to virtuous processes and specialized intermediaries in the financing of R&D institutions and activities, and on the other hand a supposed supremacy of the US production or industrial system in the innovation activity, since it can be hardly demonstrated that it is possible to be both highly innovative and little competitive in international markets.

Table 6. **Employment in manufacturing industries for the EU, Candidate countries, Japan and the US - 2000**

	Total manu-facturing	Total manu-facturing	Total manu-facturing	High-tech manufacturing	Medium low-tech manufacturing	Medium low-tech manufacturing	Low-tech manufacturing
EU-15	28482	100.00	100	9.7	27.3	25	38.1
Italy	4821	16.93	100	7.1	23.8	27.5	41.6
Germany	7551	26.51	100	9.4	38.3	24	28.4
France	4027	14.14	100	13	24.6	25.1	37.3
UK	4100	14.40	100	12.9	23.8	23.6	39.7
Spain	2595	9.11	100	4.5	21.3	28.1	46
Sweden	792	2.78	100	12.9	31.3	22.7	33
US	19533	68.58	100	17.9	23.2	21.3	37.6
Japan	12483	43.83	100	13.4	27	18.3	41.3

Source: Strack (2004).

Table 7. **Labour force education levels and occupations**

	Graduates in Science as % of total graduates (**)	Graduates in Engineering as % of total graduates (**)	Graduates in S&E fields of study as % of population (**)	Professionals on total employment (*)	Technicians on total employment (*)
EU15	11.1	14.6	1.57	n.a.	n.a.
Italy	7.7	15.4	0.83	10.9	17.5
Germany	8.9	17.0	0.93	13.0	20.5
France	15.4	15.1	2.61	11.2	18.0
UK	13.0	9.9	2.56	12.9	12.3
Spain	10.5	16.3	1.84	12.5	10.5
Sweden	10.1	21.9	1.54	17.9	19.8
US	8.9	8.4	1.28	15.8	16.9
Japan	2.8	19.9	1.84	10.2	5.5

Source: (*) OECD (2003) and (**) and Eurostat News release (2004).

A devaluation with respect to euro by more than 30% in the last two years is not consistent with a supposed greater innovativeness of the US productions and it seems rather to demonstrate the low international competitiveness of US industry. In fact, usually a country, which has the capability to improve the quality and the innovation level of its products is lead to a revaluation of its currency, being capable to ask for higher prices for its exports.

Moreover, US exports have not increased notwithstanding that large devaluation and the rapid growth of the World economy in the last two years. That seems to indicate that the cause of the low international demand for the American growth is not the price, but rather their inadequate quality and innovation content. In particular, that support the thesis that the crucial factor of the US trade deficit is the very poor international competitiveness or even the actual lack of adequate production capacity in the intermediate technology sectors, since they are both the major component of US trade deficit and those sectors, that would have been benefited by the large dollar devaluation with respect to the euro.

Finally, the 30% devaluation of US dollar has decreased by an equal amount the share of the US economy on the World GDP and it questions the real significance, at least in an international comparison, of the higher US growth rate with respect to the European economy, measured in the national currencies.

Therefore, it seems unjustified to assume the US as a model of international competitiveness. On the contrary the factors of weakness of the US economy may provide useful lectures for the direction of industrial policies in Europe.

The very low specialization in the low technology sectors, such as manufactures non machinery sectors, of North America seems to have been the reason of the decrease of the specialization and of the increase of the trade deficit in the high technology sectors, such as machinery and transport equipment sector and even in the office and telecom equipment sector.

In fact, the medium and low technology sectors represent both the source for the production capabilities in the high tech sectors and the driver of the demand of the high tech products. A strong industrial base in the sectors which apparently are defined as low technology sectors, such as the manufactures non machinery sectors, represents the necessary condition for the development of high technology sector, such as the machinery and transport equipment sector. In fact, Western Europe has a strong specialization in the low technology sectors, such as the manufactures non machinery sectors and that seems to have allowed to maintain a positive and increasing trade balance in the high technology sectors, such as the machinery and transport equipment sector.

Thus, the problem for the industrial development in Europe seems not only to consists in how to increase the exports of high technology sectors, but rather and especially how not to loose the competitiveness in the medium technology sectors.

2 From Technology Transfers to Interactive Learning Processes

The concept of “knowledge economy” or of “learning economy” lead to a substantial change in the approaches to innovation policies. In fact, according to a traditional approach technology represents an additional production factor with respect to labour and capital. Therefore, investment in R&D represents the necessary instrument for the adoption of new technologies and these latter determine the growth of productivity and then the decrease of production costs and a greater competitiveness of firms.

On the contrary the approach of the “knowledge economy”, the adoption of product and process innovation and not the diffusion of technologies is the crucial factor for the

competitiveness of firms and national economies. In particular, the scientific discoveries and the adoption of innovation by the inventors and the entrepreneurs require information, new knowledge and technical and organizational competencies, on the base of which is the development of both collective ("interactive") and individual learning processes of the labour force, technician and entrepreneurs. In this new perspective, the problem of technological development is not solved only by the growth of R&D investment, but it requires an increase of the public and private expenditure in the continuous training of the human resources and the creation of structures ("networks" or "social capital") which may facilitate the exchange of knowledge and its original integration, which generates innovations.

The development in the European countries toward the model of the knowledge economy does not complete itself in the development of new high-tech sectors or R&D intensive sectors. Moreover, the R&D investment should be integrated by policies which deal with other crucial dimensions of the innovation process.

In fact, the new knowledge economy is different from the development of high-tech industries. The perspective of the knowledge economy modifies in substantial way the industrial development strategies and also the prospects of technological change. In the traditional industrial ("fordist") model, technologies arte mainly a product, such as in the case of new equipment. Therefore, firms should invest in R&D, since that activity generates new technologies. However, they may also choose to directly buy technology on the market for technologies. Technology implies a decrease of costs and an increase of productivity. Therefore, it solves directly the problem. On the contrary, the labour creates obstacles to technologies and technology is adopted in order to substitute labour. The ideal model is that of the totally automated plant. Therefore, technologies represent a "bitter medicine" which costs both directly for its purchase and also for its costs in terms of decrease and retraining of employment.

On the contrary, in the model of knowledge economy the aim of the firms is not the adoption of technologies, but rather the adoption of product and process innovation. The innovation is not a good but a process. As indicated above, innovation requires information, new knowledge and technical and organizational competencies and these latter are the results of interactive learning processes, where the crucial actor is the human being, the innovative entrepreneur or the worker. They are not the object on which technology has an impact but the subject which promotes the innovation. That leads to the need to promote continuous learning investments at all high and low levels

and to promote the interaction between the various actors and firms, by creating networks, production clusters and intermediate institutions and in general the so called "social capital".

2.1 The Cycle of Knowledge Creation

According to an evolutive perspective technologies is knowledge. Therefore, it is linked to the process of comprehension, elaboration and assimilation of information and it has a cognitive dimension.

A modern industrial economy can be defined as a "complex adaptive system" (Holland, 2002), 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.

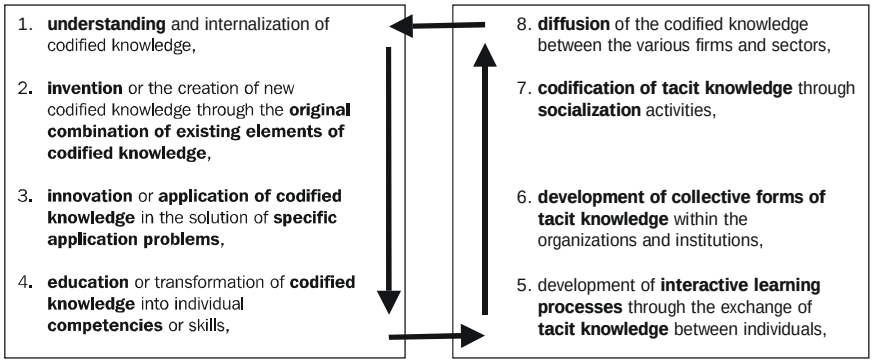
The base of competitiveness and of survival in the knowledge economy is the diversity and the cooperation between the various nodes in the knowledge networks. In fact, a knowledge economy should enhance the diversity of knowledge and competencies, since they allow the complementarities and the cooperation.

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.

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

Table 7. **The cycle of knowledge creation**



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.

Knowledge is not a private good, which is rival in the consumption, neither a public good for which the principle of exclusion is not valid. It is the result of interactive learning processes between various actors. Therefore, knowledge does not exhaust itself in the use, while the continuous use of knowledge generates new knowledge.

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, in which the role of tacit knowledge is crucial. In fact, tacit knowledge insures both the comprehension of codified knowledge, which was imported from outside (phase 1), and the capability to combine in an original way codified knowledge (phase 2) as also 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 are 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 the individual actors represents the base for the development of interactive learning processes which lead to the further development of knowledge (phase 5). This underlines the cumulative character of the process. These

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).

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 whether is not accompanied by the development of the receptivity of the involved actors. However, the development of understanding capabilities requires the availability of tacit knowledge (phase 1).

2.2 The Definition of Innovation

According to a wide definition, innovation should include new products and services, major changes of production methods, incremental improvements in the processes and products, new approaches to marketing, new forms of distribution, change in the management approaches and in labour organization and changes in the competencies of the labour force.

Industrial innovation often is not the result of a formal and planned research activity which aims to new products and services, but rather the result of an informal “search” activity or of a long term process of interactive learning between various actors which are independent one from the other and based on a creative integration of four components:

a) the knowledge of one or more rather advanced technologies in a specific sector;
b) the intelligent use of a system of various innovative equipment, software and intermediate product and services, which have been recently developed in other sectors at the national and international level;
c) the original identification of technical problems and specific needs of potential users and the gradual development of new applications for specific not yet exploited market;

d) a continuous public investment in the development of technical standards, social norms, and organizational, financial and institutional solutions, which may facilitate the adoption of the considered innovation.

The concept of innovation is neither limited to the adoption of individual new products and processes nor in the development of new products by the individual firms. It may consists in the development of continuous learning processes, which lead to an even gradual change of the organization of processes and products within the individual firms, and also in the systemic change of the organization of production processes, which are performed by various firms, which are vertically or horizontally integrated within specific sectors and clusters. Finally, innovation may consists not only in new products but also in the development of new markets, which are created by the capabilities by new types of products to respond in an original way to the new needs of industrial or final users.

2.3 The Role of Tacit Knowledge, Informal Research Processes and Competencies

The distinction between codified and tacit knowledge is of great relevance. However, together with this almost traditional distinction it is necessary to associate the distinction between the formal research activities and the informal search activities as also the distinction between the development of innovation/inventions and the development of internal competencies within the firms.

In fact, the development of tacit knowledge, combinatorial knowledge and non formalized research activity based on interactive learning processes within the networks of firms emerge as crucial factors in promoting innovation processes especially in the medium and low technology sectors and in the small and medium size firms.

In particular, as indicated in table 8, innovation process can be characterized by specific forms of combination between different inputs, processes and outputs (Cappellin, 2004c).

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.

Table 8. **The relationships between: a) types of knowledge, b) types of research processes, c) development of competencies, d) invention and innovation within the interactive learning processes**

<table>
<tr><td>University institutions</td><td>Large firms</td><td>Formal research</td><td rowspan="2">PROCESS</td><td>University institutions</td><td>Large firms</td></tr>
<tr><td>Knowledge intensive services</td><td>SMEs in non high-tech sectors</td><td>Informal research</td><td>SMEs in non high-tech sectors</td><td>Knowledge intensive services</td></tr>
<tr><td>Codified knowledge</td><td>Tacit knowledge</td><td colspan="2" rowspan="2">INTERACTIVE LEARNING PROCESSESS</td><td>Competencies</td><td>Invention or innovation</td></tr>
<tr><td colspan="2">INPUT</td><td colspan="2">OUTPUT</td></tr>
<tr><td>University institutions</td><td>SMEs in non high-tech sectors</td><td>Competencies</td><td rowspan="2">OUTPUT</td><td rowspan="2"></td><td></td></tr>
<tr><td>Knowledge intensive services</td><td>Large firms</td><td>Invention or innovation</td><td></td></tr>
</table>

Source: Cappellin (2004d).

Innovation policies mainly focus on the financing of only R&D activities in the individual firms. Firms are understood as a "black box" which organizes given factors and produces by choosing between given technologies. Therefore, the aim of public incentives is to facilitate the access to these technologies. On the contrary, firms represent an evolutionary system, which on the one hand adapts to the change and on the other generates new production combinations, through a well known "creative destruction" process. That requires that firms develop:

- the strategic capabilities which are linked to the generation, identification and exploitation of economic opportunities: a capability which pertain to the top management;
- the adaptive capabilities which are linked to the learning of previous experiences and to the reaction to changes, which should characterize all organization levels.

That approach implies a critique to the linear and sequential model, which is focused on the radical technological innovation based on R&D investment.

The innovation process has systemic characteristics and it requires the tight integration between high tech sectors and medium and low technology sectors. The innovation and productivity growth are a rather horizontal phenomenon which seems quite apart from the average R&D intensity of the individual sectors. More important is the relative R&D intensity of the firms in a given sector with respect to the competing firms in other countries and regions.

Therefore, a strong and growing specialization in the so called high tech sectors can not represent the main objective of a national or European innovation policy.

2.5 The Concept of Sectoral, Regional and National "Innovation Systems"

The concept of "innovation system" clarifies the crucial role of the governance of the interaction between the main actors of innovation. It is completely different from the "linear" approach, which characterizes the alternative concept of "technology transfer" and it represents a new paradigm which is currently adopted by international organizations, such as the European Union and the OECD and various national governments and regional institutions. It is clear that a sectoral/regional/national

"innovation system" represents a wider and more complex concept of the research community or the university world or the only realm of the high tech or science based sectors. In particular, a national innovation system (NIS) may be represented as a matrix made by regional innovation systems (RIS) and of sectoral innovation systems (SIS)[7].

Interactive relationships in an innovation system are various and do not only consist in the buying and selling of intermediate products and services, or in financial transactions or in information and knowledge flows between the various firms and actors. A key role is played by the mobility of people and by personal relationships, the sense of common belonging to specific social or productive communities, which are characterized by specific values, norms, languages and technological standard (Cappellin, 2004b).

A regional innovation system is made by firms tightly embedded with other firms of various sectors, with clients, suppliers and partners as also with centres of knowledge such as universities, research centres and technology transfer agencies and a set of governance structures such as private industrial associations, chambers of commerce, training and development agencies and local and national public institutions.

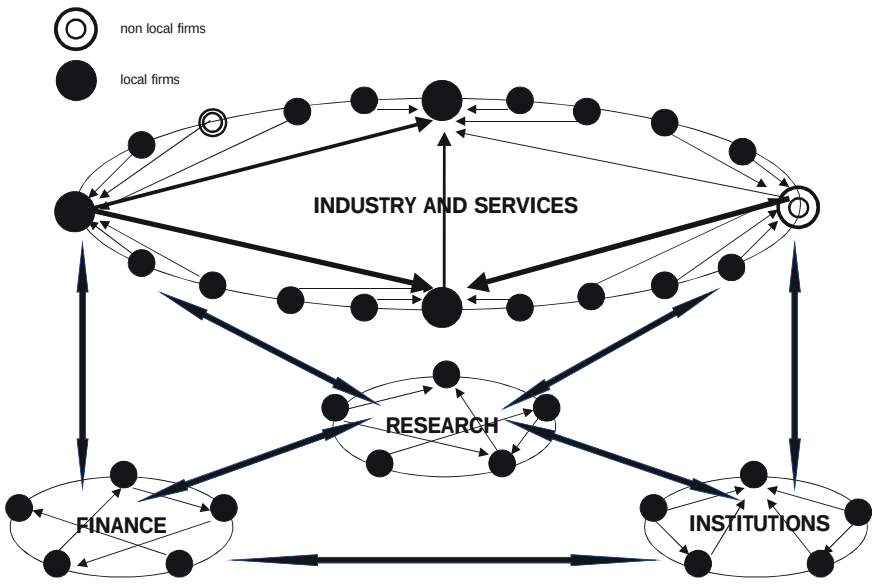
2.6 The Structure and Evolution of Knowledge and Innovation Networks

In the case of small and medium size firms and of intermediate technology sectors the process of learning, knowledge creation and innovation is the results of a tight interaction between various actors and it is not only or mainly the result of the internal activity within the various firms, as the flows of information and know-how ("tacit knowledge") is embedded in the networks of relationships between the various firms and local actors.

Network forms of organization due to their flexibility and openness often prove to be more appropriate in order to manage the relationships between the various heterogeneous and complementary actors in the innovation process than the competition mechanisms within traditional markets or the power relationships within hierarchical structures.

[7] *See Chung (2002).*

Table 9. **The network of links in a national / regional innovation system**



Source: Cappellin (2004d).

Thus, the network approach may prove to be most appropriate for the organization of industrial and innovation policies in countries facing major restructuring problems such as the new accessing countries and Croatia.

The structure of a network of firms may be represented as in the figure 9, where the various firms, organizations and institutions are grouped within a four specific clusters or sub-networks, corresponding to the four main elements of a sectoral/regional/national innovation system:

- industrial and service firms,
- research and university institutions
- financial intermediaries,
- local and national public institutions

Some of these actors are local, while other important actors in a network may belong to other regions or countries and characterize the openness of the network and increase the diversity and the complementarities of the nodes belonging to a given network.

The structure of a network is characterized by:

- nodes, which may be firms and other private and public actors,
- links or flows, which may be material or immaterial and in an economic context are made by products and by production factors,
- distance, which is not only geographical but also technological, organizational, cultural, institutional, distance and which determine specific obstacles or transaction costs in the circulation of the flows,
- infrastructures, which reduce the distance and facilitate the circulation of the flows and give stability to the network and may be material or immaterial, such as norms, institutions and social capital.

The network structure affects and is affected by the network behaviour, which is determined by the aims of the various nodes or actors and the agreements reached between these latter on common objectives.

Network analysis allows examining various crucial dimensions of knowledge and innovation networks. Network analysis usually focuses on the measurement of various indicators which describe the form of a network. However, it could also study:

- the homogeneity between the internal characteristics of the various nodes or their "distance" measured as difference in technological level and in internal organizational characteristics,
- the rules regulating the reciprocal relations between the various nodes or the "institutions" and immaterial infrastructures which facilitate or hinder the relationships between the various nodes,
- the relationships between the behaviours of the nodes and their internal characteristics and the rules which characterize a given network.

Moreover network analysis may allow studying the evolution of the network form in time (Cappellin, 2003) or:

- the changing intensity of the existing flows between any couple of nodes,
- the creation of new linkages between nodes which were previously disconnected or the disappearance of some existing linkages,
- the creation of new nodes or the disappearance of existing nodes.

Networks performance is related to the balance between the transaction costs between the nodes and the exploitation of network economies or synergy effects. In particular, the governance of a network aims to a flexible balance between apparently contradictory characteristics and processes, such as:

- homogeneity between the various actors of the network and diversity and complementarities of the competencies and characteristics of the same nodes,
- thickness of the network or tight integration between the various actors and relative isolation or specificity of the nodes characterized by outstanding excellence,
- integration and cooperation between the various nodes and the preservation of clear distinctive competencies and roles of the various actors, to avoid forms of collusion,
- cooperation between the various actors and existence of conflict of interests and complex negotiation procedures between the same actors.

The experience of other countries in Europe indicates that within a network or a sectoral/regional/national innovation system may emerge three types of problems (Isaksen, 2001), such as:

- the lack of density or of a significant number of diversified actors that would be necessary to promote interactive learning processes: a case which is frequent in economic lagging regions,
- the fragmentation or the lack of cooperation and thrust between the various actors characteristics: a case that may occurs in large metropolitan regions where the individual actors work in different worlds not communicating each other;
- the lock-in effects and the obstacles to accept innovation too distant from traditional approaches: a case that often occurs in the highly specialized regions facing industrial reconversion problems.

2.7 International Openness as a Factor of Innovation and Development

The actual “knowledge society” is characterized by the rapid enlargement of the production processes both in a geographical and institutional perspective. Even local clusters are increasingly integrated in the regional, national, European and global economy. Thus, local networks are gradually extending at the international/interregional level.

While internal integration between the various local actors and institutions is a key factor of development, a complementary and seemingly opposite factor is the degree of diversity and of openness of a regional economy. Diversity and openness are crucial in order to avoid that the integration between local actors is not leading to lock-in effects and to allow the combination and synergy between actors of different regions and countries.

External stimulus and collaborations are required in the process of industrial restructuring and to improve the international competitiveness of regional or national industry. Interactive learning processes should develop not only between the various local actors but also between these latter and external actors and innovation policy should remove the obstacles hindering the development of external relationships.

In a globalized world of freely moving capital and increasingly freely moving people, only social capital remains tied to specific locations. Thus, the “learning economy” is characterized by the hyper-mobility of the information and knowledge and the local character of the social capital.

Participation to international learning processes and innovation networks is affected by internal receptivity and by internal institutional thickness. The receptivity or absorptive capacity of new technologies by a firm corresponds to the quantity of external knowledge it is able to utilize and is related to the technological distance and to organizational/ institutional proximity between two economic actors. Clearly, the absorption capacity of a specific regional production system is related to his level of social capital and institutional thickness.

Moreover an effective international transfer of codified and tacit knowledge requires a higher similarity of the institutional framework between the regions and countries involved. The existence of common values, history and traditions together with the international partners facilitates cooperation and the participation to interactive learning process at the interregional level. In fact, knowledge transfers may become not territorially bounded, when culture, organizational framework, social capital and institutions are common or harmonized.

Thus, the connectivity between the various institutions should be a central concern of policies aiming to extend to an interregional and international dimension the interactive

learning processes and of innovation networks, actually existing within a limited local framework (Cappellin, 2004b).

3 The Role of Institutions Within Networks and the "Governance" of Innovation Policies

Knowledge is channeled within networks by formal and informal institutions. While explicit and codified knowledge may be traded on markets, tacit knowledge competencies and skills can not be transferred effectively through conventional markets. Institutions have a key role in the governance of knowledge and innovation networks as they can:

- reduce transaction and production costs,
- increase trust among economic and social actors,
- improve entrepreneurial capacity,
- increase learning and relational mechanisms,
- reinforce networks and cooperation among the actors.

Thus 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. Institutions have a key role in the process of innovation and in the generation and working of "knowledge and learning networks". A wide range of institutions is required in the process of innovation.

Regional governments are required for attracting external investments, to coordinate large strategic projects and to promote the birth of new firms and entrepreneurial capabilities.

Local governments are required for an effective territorial planning and for the creation of efficient transport and logistics infrastructures.

Local credit institutions are required for the financing of innovative projects by existing firms and to enhance the creation of new firms.

Local education institutions, such as vocation training and university institutions are required for the identification of labour skills required by the new technologies and for maintaining the traditional productive skills in a given territory.

Labour agencies, trade unions represent specialized institutions required for an effective management of the local labour markets and to facilitate the interaction between the supply and the demand of labour, the wage negotiation procedures and the management of the "welfare" system.

Chamber of commerce and industry associations are major partners in promoting a regional innovation system and in the identification of strengths and weakness and of strategic lines of competitiveness and development.

The concept of "knowledge economy" is tightly related to those of institutions and of "multilevel governance", social capital and immaterial infrastructures. Moreover, it is crucial to identify forms of coordination and "institution building", which are most appropriate in the case of a "knowledge economy".

The expression "governance" is used to indicate decision making systems where the decisions are not taken through the traditional hierarchical processes with a public authority at the top ("government"), but rather through open forms of collaboration between a variety of public and non public actors, which may vary according to the policy area and the level of government to be considered. Governance operates within complex networks and the decision making processes include forms of horizontal and vertical negotiation, where the exercise of a hierarchical power is only a component and often not the most important.

"Multi-level governance" defines a new mode of regulation and coordination based on heterarchic negotiations around interfirm networks and public private partnership. It is based on negotiations or strategic alliances between multiple stakeholders in order to secure agreed objectives which are mutually beneficial.

Thus it is important to underline the difference between the traditional "government" model, based on economic planning, state intervention, and public owned firms and the "governance" model based on negotiation, coordination mechanisms and "intermediate institutions".

It is now widely recognized that the dirigist model ("government") in the innovation policies is neither possible nor desirable, since innovation for its very nature can not be reduced to command ant it has a pro-active character and it is open to new discoveries. Innovation depends on the autonomy and active collaboration of researchers and

entrepreneurs, rather than on passive obedience. Incentives and negotiations, rather than orders seem to be the main instruments in order to promote and manage innovation.

Within a network, the policy-maker can not adopt typical hierarchical methods, such as traditional planning ("government"), but it should be capable to guide or to steer ("governance") the network of the various economic, social and institutional actors, in order to promote the flows and to orient the relationships between these latter, for promoting self-sustained economic development processes.

Whether the "government" model is not appropriate to the modern innovation policies, it is clear that the free market approach based on the only regulation of prices and competition is inadequate to manage the issue of innovation.

The speed of information flows and of decision making processes is tightly related to the stability of the organizational forms and it depends on the existence of a well developed institutional system ("social capital") and from immaterial structures and infrastructures which facilitate the relationships between the various actors participating in the innovation process and reduce the transaction costs. In fact, the instability and the risks associated with the market mechanisms lead the various actors of a given innovation system to search a shelter in more structured organizations and in a framework of shared values, leading to collaborations and avoiding negative forms of competition.

Moreover, the innovation processes are tightly connected with the division of labour, the specialization and integration of various production phases and labour competencies. This increasing labour division requires a framework, which allows connecting the contributions of different firms and actors. Institutions and economic policies have a crucial role in the development of systemic interactions between the industrial firms, the financial system and the training of human resources and scientific institutions and in the development of forms of production integration, leading to local and also global supply or value added chains. Therefore, a social and institutional framework is required by the processes through which tacit knowledge is transformed into codifies knowledge and is incorporated into a complex innovation.

Knowledge circulates within networks through formal and informal institutions. While explicit or codified knowledge may be exchanged on technology markets, tacit knowledge has an asymmetric character and it is non tradable, while it requires allocation mechanisms which are different from the markets. Only specific organizations

and institutions and not traditional markets are capable to insure the access to information and those connections which allow the exchange and the tight interaction of knowledge, competencies and technology transfers. These organizations may be made by large multinational companies, joint projects for new productions, norms and technical standards between the participants to a network, local networks or clusters of firms, forms of public-private partnership or large “network of excellence” between research institutions.

Institutions reinforce the identity and reciprocal thrust and allow limiting the disadvantage of the asymmetric circulation of information, reduce uncertainty and the risks related to the unforeseeable results of innovations, increase the incentives to invest for medium and long term projects and support investments in specialized training, which may increase the receptivity to innovation by the various actors.

The transition to the model of the knowledge economy requires the creation of new hard and soft infrastructures, both at the local and at the European level, which may facilitate the enlargement of the knowledge and innovation network in order to include also the economic lagging regions, sectors and firms (Cappellin, 2004a). However, the creation of these institutions requires appropriate investments, as networks can be considered as a form of capital, which requires collective economic resources for their creation and maintenance and without which the “social capital” would be lead to a progressive decay.

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