KNOWLEDGE AND INNOVATION NETWORKS

AND TERRITORIAL KNOWLEDGE MANAGEMENT

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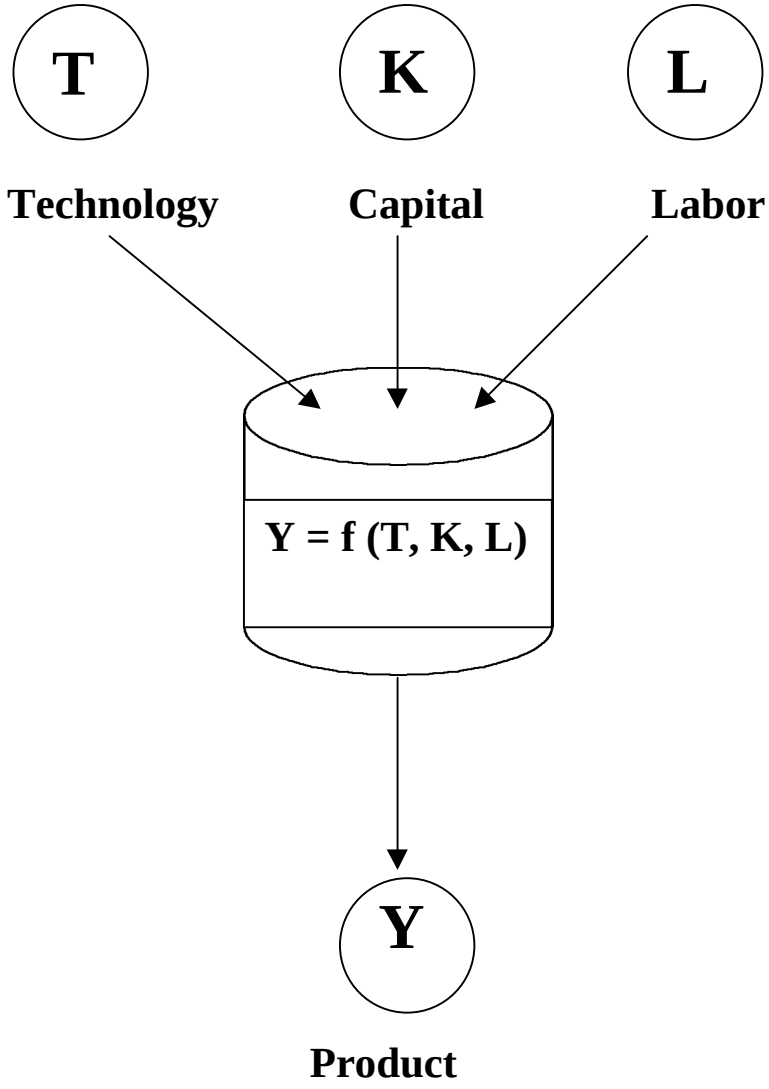
The neoclassical model of the production function

In a neoclassical model, the growth of the production in a regional or national economy is determined through the tool of the aggregate production function, which indicates the effect on the production level of the use of various production factors, such as capital (K) and labor (L), given the characteristics of the technology (T), as this latter is supposed constant among all firms, as indicated in figure 1.



$$\Sigma_i Y_i = f(T, \Sigma_i K_i, \Sigma_i L_i) \qquad \text{aggregate production}$$

Figure 1: The model of the neoclassical production function

The networks of firms in the local production systems

According to the approach of "territorial networks" the various forms of integration or the various networks, which may be identified in a local economy, may be described as in table 1 (Cappellin and Orsenigo 2000).

Table 1: Different networks in a local production system

Technological integration, pointed out by the development of the local production know how, the sharing of knowledge and values promoted by learning processes on the job, the continuous education of the workers, the vocational education of young workers, the joint investments in R&D by local firms and the technological cooperation with external firms.
Integration of the local labor market, related with the cooperation between the workers and the firms and the mobility of the workers between the firms of the same sector and also the capability to attract qualified workers from other regions and from other sectors.
Production integration between the firms, through subcontracting relationships between the firms which play a crucial role in promoting the gradual diversification of the local productions.
Integration between the service sectors and the manufacturing firms, related to the development of modern commercial distribution services, transport and logistic services and also qualified services in the certification of the quality of the productions and in the diffusion of modern technologies.

Financial integration of the firms, as it is indicated by the creation of groups made by several firms belonging to the same entrepreneurial family and by pro-active bank-industry relationships, which promote the creation of spin-off and the capability to attract external investments or the investments of local firms in other countries and regions.
Territorial integration at the local level, which requires an improvement in the infrastructure endowment and it is linked to an effective physical planning aiming to defend the quality of the territory.
Social and cultural integration, which determines the existence of a local identity and the creation of the consensus within the local community on a shared developed strategy.
Relationships of institutional integration, which are related to the development of local administrative capabilities and the capability of the local institution to interact with the regional and national institutions in the implementation of strategic development projects.
Territorial integration at the interregional and international level, which leads to a greater openness in an interregional perspective, to the development of a local “foreign policy” or of a “territorial marketing” measures, which are crucial in attracting external investments and in promoting the internationalization of local firms.

An analytical representation of the model of territorial netwoks

The firms of a local production system may be represented as in the figure 2**:**

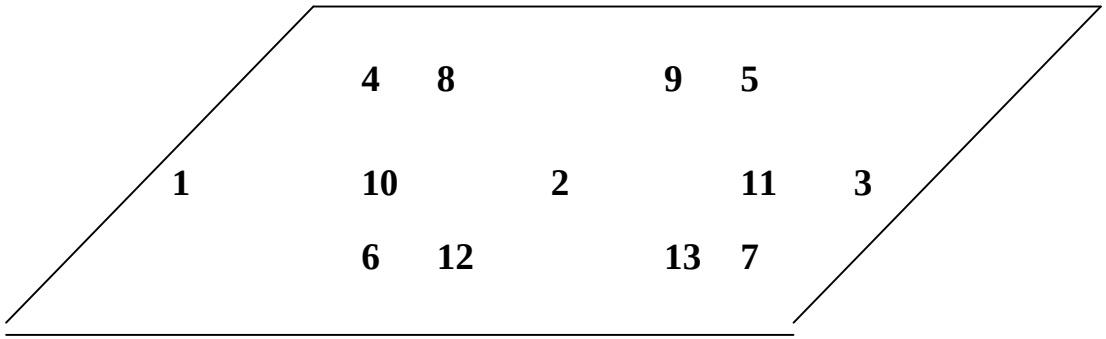


Fig. 2 The firm in a local production system

According to a network perspective, the working of a national or regional economy is explained by the integration between the various firms. These relationships may concern the same four variables, such as product (Y), labor (L), capital (K) and technology (T), which are traditionally considered in the neoclassical model of the production function. That allows to extend this model to the case of four interactive networks. Thus, an economic system may be described by four functional networks, as indicated in figure 3.

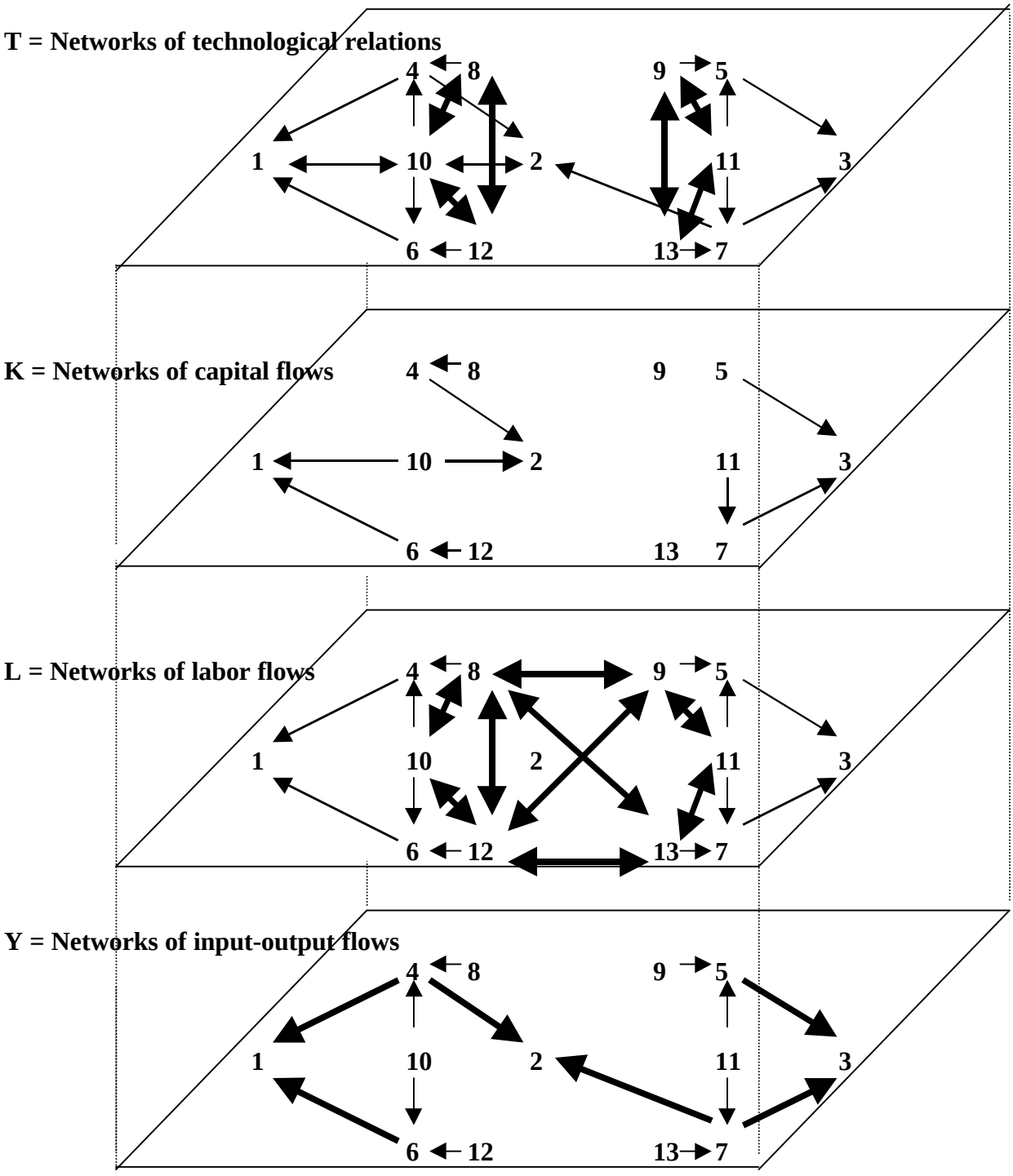
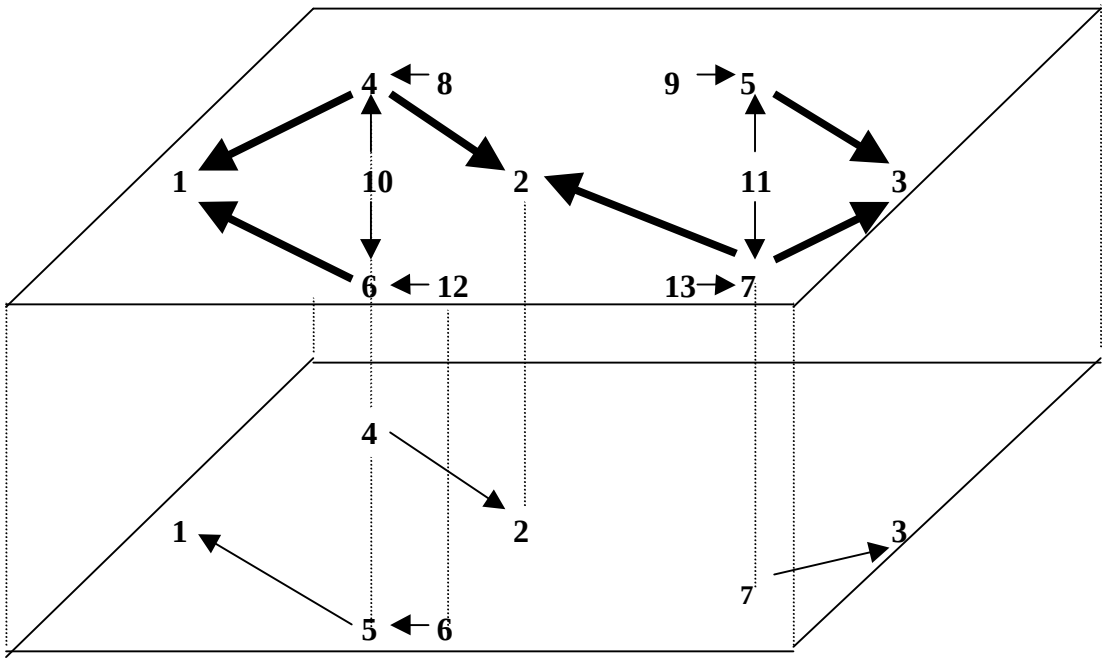


Fig. 3: The connectivity between the flows of production factors, technology and productions

T1 = Final subcontracting networks



T0= Initial subcontracting network

Fig. 4: The interconnection of three different networks

	1	2	3		1	2	3		1	2	3		1	2	3	
1																
2		T				TK				TN				TY		
3																
1																
2		KT				K				KN				TY		
3																
1																
2		NT				NK				N				NY		
3																
1																
2		YT				YK				YN				Y		
3																

Tab. 2 – The interconnection between production, labor, capital and technology flows

Output = n_1 (output flows)

Output < Production capacity

Production capacity = Resources * Productivity

Resources = n_2 (input flows)

Productivity = n_3 (knowledge flows)

0 =n_4 (output flows, input flows, knowledge flows)

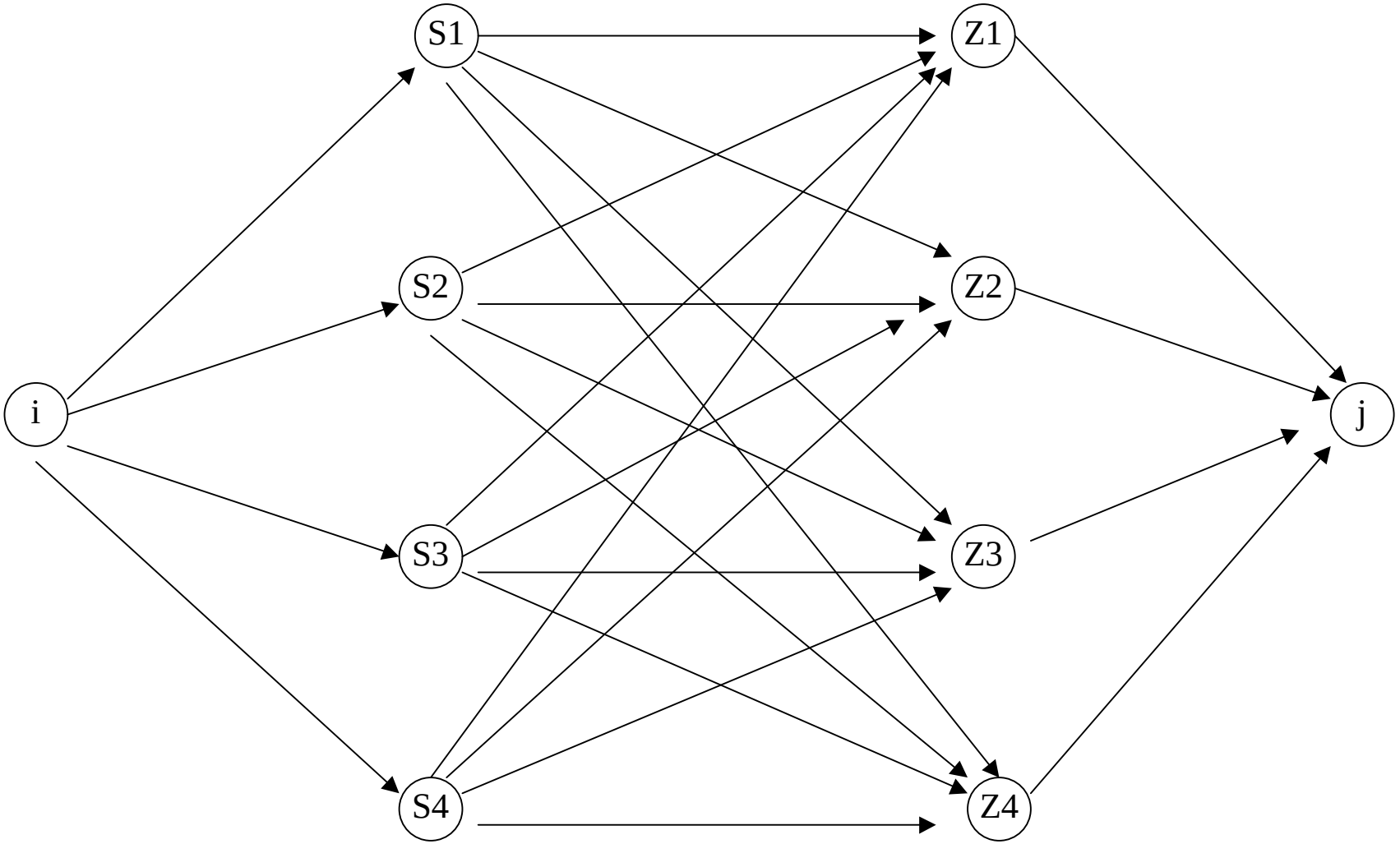


Fig. 5 – The indirect links between two nodes i and j through two intermediate nodes

Thus, the distance and the respective cost (transaction cost) in linking **two nodes (i) e (j),** which are not directly linked between themselves but belongs to the **same network**, may be measured as:

$$\mathbf{c_{ij} = \Sigma_{s\ A} d_{is}\ (x_{is}/x_s)(x_{sz}/x_z)(x_{zj}/x_j) + \Sigma_s\ \Sigma_{z\ A} d_{sz}\ (x_{sz}/x_z)(x_{zj}/x_j) + \Sigma_{z\ A} d_{zj}\ (x_{zj}/x_j)}$$

when up to two consecutive **intermediate nodes (s) and (z)** are considered.

However the relationships between two nodes which are not connected in a particular network (I/O network, for example) may occur indirectly through an intermediate node, which belong to the two respective networks to which the two nodes participate.

In general terms, the unit cost of the relation between **two nodes (j) and (z),** which respectively belong to **networks A and B** and are only indirectly connected through various intermediate nodes (s) belonging to both networks, may be measured as:

$$\mathbf{c_{iz} = \Sigma_{s\ A} d_{is}\ {}_{AB}d_s\ ({}_Ax_{is}/{}_Ax_s)\ ({}_Bx_{sz}/{}_Bx_z) + \Sigma_{s\ B} d_{sz}\ ({}_Bx_{sz}/{}_Bx_z)}$$

where the coefficient $({}_{AB}d_s)$ indicates the element of the **connection or transition matrix** between the network A and the network B and it allows to transform the measure of the distance in the network A in the unit of measurement of the distance in the network B, in order to compute the total transaction cost.

The incentive for a couple of actors or nodes to **establish a new link** or to **increase/decrease an existing link** depends on the respective perception of the other actor or **node characteristics**, such as its position within the overall network or its **distance with respect to other nodes**, taken into account the existence of intermediate nodes. Moreover, this incentive depend on the direct and indirect **relationships developed in the past** or the existence of a cumulative learning process.

Thus, the adoption of a network perspective allows to focus some **new aspects of the process of technological change**. In fact, in a network perspective, technological change may be interpreted as the result of the **continuous or gradual search** by each node, of **the most appropriate level and form of integration** or co-operation with the other nodes or actors within the network. Technological change is similar to a process of **iterative adaptation of the direct and indirect links** between any couple of nodes in order to **maximize their respective interaction** and integration.

Technological change is related to the effort to minimize the distances (d_{ij}) and ($_{AB}d_{ij}$) existing between the various nodes, by establishing new links or forms of connectivity, which may be both direct or indirect, and by improving and making more intense the existing links.

This **process of adaptation** and co-evolution of the relationships between the nodes of a network may be defined as **a process of learning and of knowledge accumulation**.

In particular, the **theories of organizational learning** emphasize the **cognitive processes** among organizational agents, the role of rules and the **interactive processes of learning** in **loosely coupled organizations** (Granowetter 1985, Capra 1996, Morgan 1997, Nonaka and Konno 1998, Lawson and Lorenz 1999, Maillat and Kebir 1999, Maskel and Malberg 1999, Rubenson and Schuetze 2000, Cappellin 2000b).

As in the **models of neural networks**, an innovation is the result of an **adaptive learning or searching process**, which leads to **new synaptic connections of various nodes**.

A scientific breakthrough and an innovation occurs, when the **joint impulses or signals** coming from other nodes not only are **compatible** with the node considered, but they also overcome **a certain threshold of intensity**.

That allows the node considered to **perceive this stimulus**. The node may then decide whether to **conflict with it** or rather to **adapt to it**. In fact, whether the stimulus is **compatible with the existing cognitive system**, an **interactive processing** may lead to identify an incremental solution to an existing problem and that **stimulates the act of innovation**.

In particular, **technological change** may be related to:

- **intensity of the interaction** between the various nodes of a network **through the existing links**. That is related to the **interactive characteristic of technological change**, which is based on interactive learning processes,

- the speed of change of the links between the various nodes of a network through the **creation of new links**. That is related to the **combinatory characteristics of technological change**, which is made by an original combination of already known logical concepts or concrete artefacts, but which were previously disjoint.

Technological change has both a productive dimension and a cognitive dimension. The first dimension is related to the **chance in the adopted technologies** or to the **changes in the division of labor** between different firms. These changes are related to the level of transaction and change costs and they determine the flows of product and services, which jointly determine the overall national production. The second dimension is related to the **combination of information flows or of different theories or models** and is related to the process of **knowledge creation**, which has a crucial role in a modern “learning economy”.

That demonstrates the tight connection or complementarity between the networks of production and of input flows and the networks of knowledge flows, indicated in figure 2. In fact, knowledge generates organizational change or the change in the input-output flows between the firms and actors, while it is also generated by organizational change or by the change in the structure of the networks of production relationships between the various firms and actors (Capra 1996).

We may conclude that networks are characterized by four main parameters:
- the **distance** and obstacles to be overcome in the links **within a given network**,
- the **connectivity** between the **different functional networks**,
- the speed of change of the links and the **creation of new links**,
- the **evolution trajectory** of the overall form or **structure of a network**.

In fact, it has to be recognized that a greater research effort is needed in order to investigate the nature of these four parameters and that the network approach is very different from the neoclassical approach, which represents the traditional base of economic analysis.

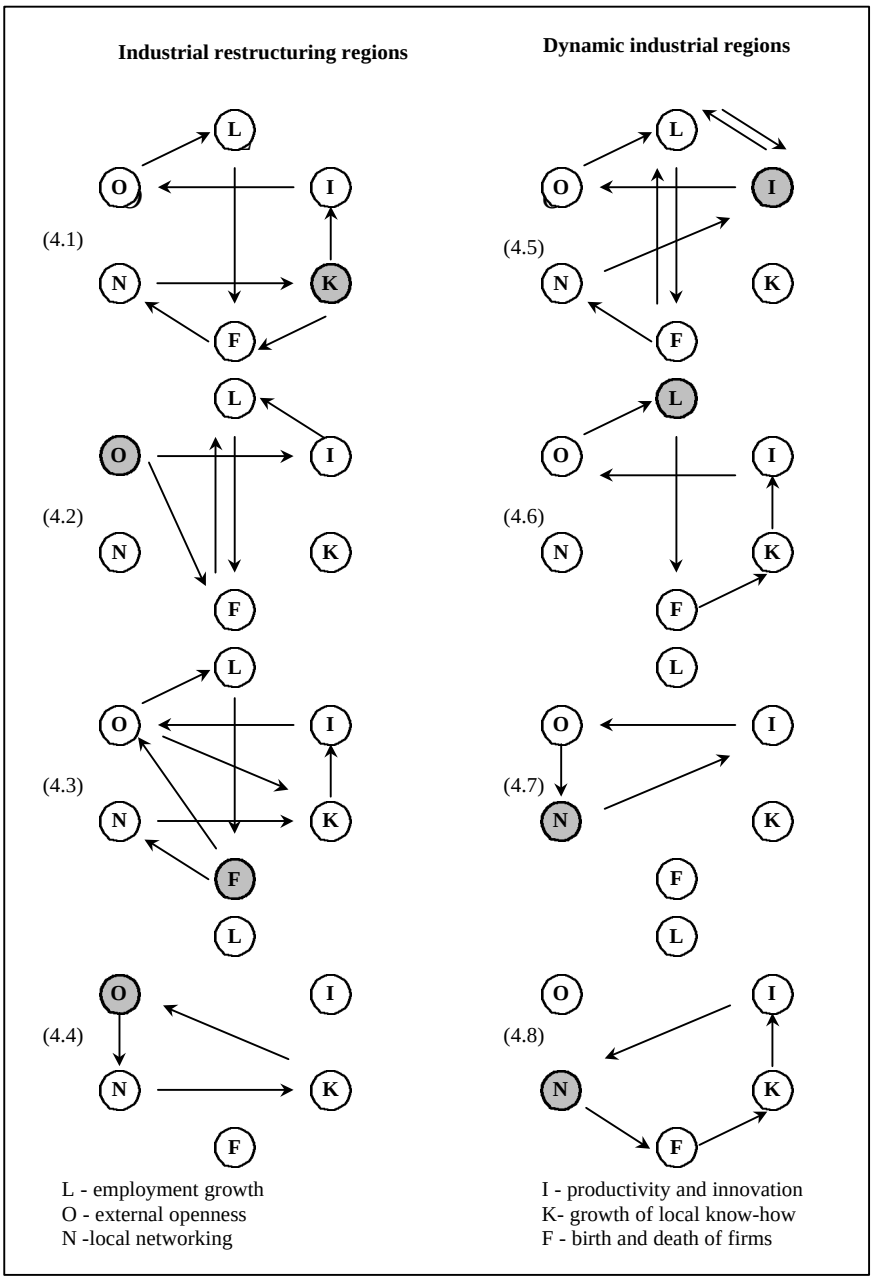


Fig. 4: International openness and governance of local networks

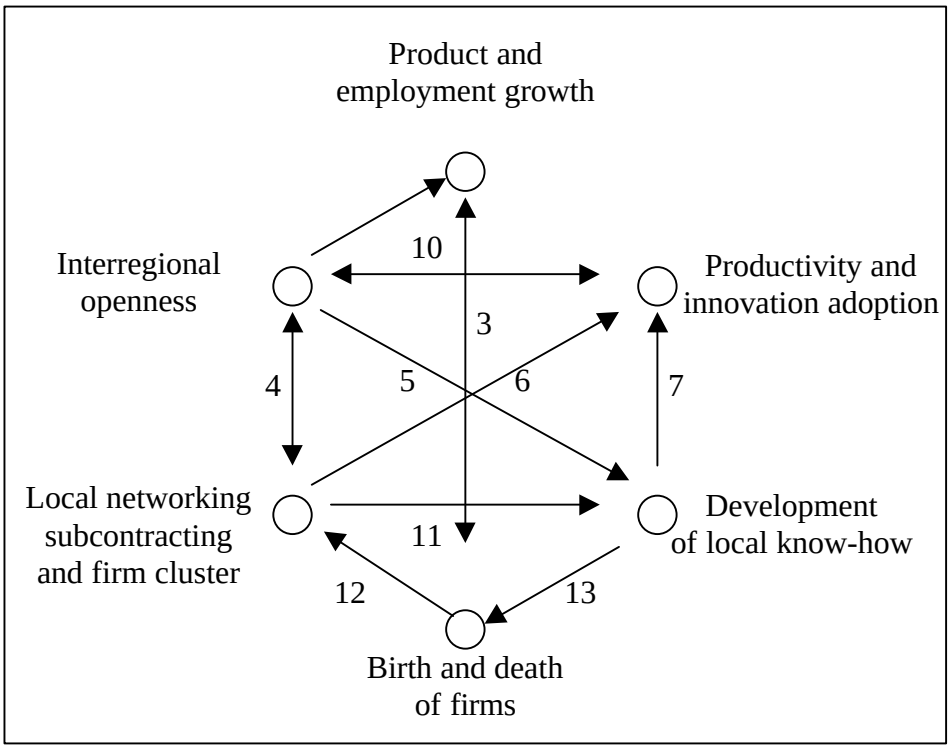


Fig. 7 - The effects of traditional regional policies in economic lagging regions

5. A “transactive approach” in regional innovation policies

While explicit and **codified knowledge may be exchanged on the markets**, **tacit knowledge** can not be sold and **requires mechanisms of allocation different from the market**. The transaction of knowledge should be **mediated by networks** and other forms of organization, which allow to increase thrust, limit the negative effects of asymmetric information and reduce the transaction costs (Williamson 2000).

Clusters and networks as a specific expression of innovation processes can be regarded as **a form of Coase institution** (Coase 1992) that tries to integrate the positive external effects of innovation, technological knowledge and development activities (Coleman 1988, Keeble et al. 1999, Lagendijk and Cornford 2000).

In a policy perspective, as indicated also by the **modern economics of institutions** (North 1990, Putnam 1993, Cooke and Morgan 1998) the network model underlines that the **governance of the economic relations** requires that the national State, the regional and local governments and the various public-private “intermediate organizations” perform the **role of a facilitator aiming at “network steering”.**

Thus, national and local public **institutions** and collective intermediate organizations **are not an economic sector** as other industrial or service sectors, in which actors are guided by the principles of methodological individualism and often have opportunistic behaviors. On the contrary, as indicated by institutional theory, they define the **system of rules, procedures and linkages** which allow to the economic actors to interact among themselves and to achieve **higher forms of economic integration** or in other terms should promote the participation of a multiplicity of subjects and the coexistence of many interests.

As **transport infrastructures** are crucial in order to integrate the various firms, to develop **modern JIT systems** and to **reduce the production times**, the existence of organizational infrastructures and of public and intermediate institutions is crucial in order to integrate among themselves the various actors in the markets or networks of production factors and to enhance the knowledge networks, which characterize a “knowledge economy”. In particular, local institutions have a crucial role in **integrating among themselves the various different functional networks existing in a specific territory**.

Industrial policy should pass from a "distributive" logic of financial incentives, to a logic of regulation/deregulation. Therefore, networks require a shift from a "**prescriptive" policy**, which in a dirigist manner indicates specific productions or technologies, to a **"transactive" policy** (Cappellin 1997), that aim to act on the transaction costs or on the relationships of integration between the individual firms and to facilitate the technological and organizational changes in a given geographical or sectorial cluster of firms.

In particular, the **governance or the steering of economic networks** implies that the policy makers aim to facilitate the flows, which integrate or interconnect the different functional networks among themselves.

That may imply that the governance process will try to **orient the relationships between the various blocks in figure 4** in the “right” directions, thus **enhancing a virtuous and not a negative cumulative circle** of development.

A methodology for Territorial Knowledge Management

As the process of knowledge creation plays a crucial role in the development of an economic system, policy makers may attempt to **promote the internal efficiency or integration of the knowledge creation block (K)** indicated in figure 4.

In fact, **the system of social relations, where entrepreneurs do operate, is extremely expensive to operate and maintain**. Even if it remains difficult to "monetize" its costs, the process of continuous restructuring and re-qualification of a local production system is time- and energy-consuming.

This policy may require **investments in continuous learning** and measures **promoting the external openness of the local economy** and facilitating the relationships of a local production system with external research centers and external technologically advanced firms.

Many regional networks or innovation systems are faced with problems of cognitive or functional blockades only oriented on established ideas, partners and technologies.

In fact, **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.

Defining a region as a "learning region" means to contend 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 the tacit or implicit traditional knowledge (**Nonaka and Konno 1998), **which is bound to the local context**, **with the codified knowledge available at the world level**, in order to stimulate the regional endogenous potential.

The explicit objective of an innovation policy at a regional scale may be that of **"creating value" from information and knowledge embodied in the human resources in the local territory**, as indicated in the "knowledge management" approach recently developed in the field of business economics (Little et al. 2002).

The objective of the **"Territorial Knowledge Management" (TKM)** should be that of favoring the individual firms in getting **access to the information they need**, developing their **capacity to collect, organize, and make available in real time the information** necessary for decision making and for carrying specific production activities.

Territorial Knowledge Management (TKM) aims to **convert localised and tacit knowledge of the firms and of the individual workers into organised and explicit knowledge,** common to all actors of a sectoral/regional cluster.

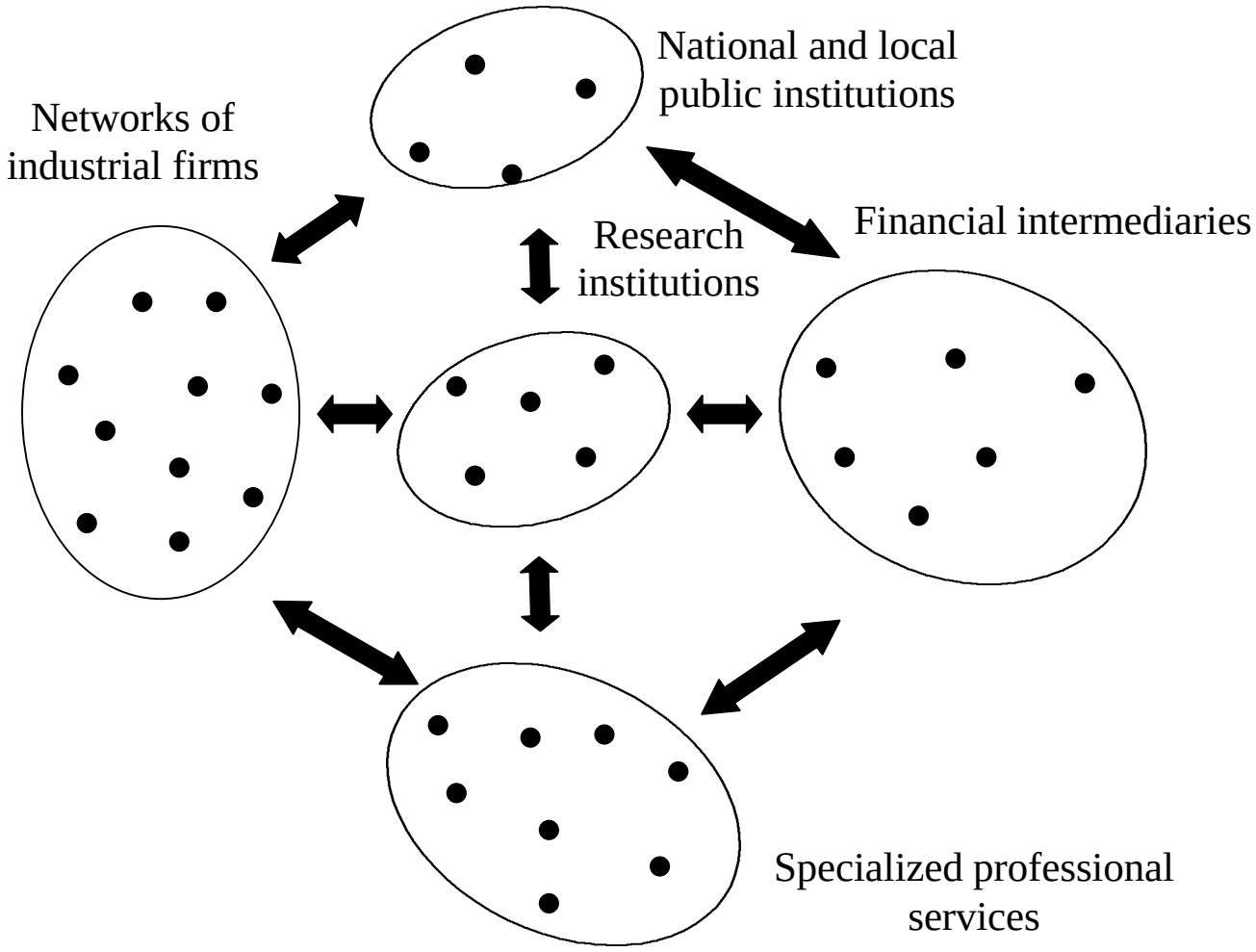
Territorial Knowledge Management (TKM) aims to **make more explicit and formal the organization of knowledge interactions,** through which the firms and the actors in a traditional production system circulate the required information and competencies among them **in a too implicit, complex and slow process**.

It also aims to **facilitate the acquisition from outside of knowledge**, which may be crucial for the competitiveness of the overall regional production system. That implies an assessment of regional and sectoral experiences in order to **look for suitable supplements outside the region** (depending on experiences and contacts of the different partners) and **for suitable institutional arrangements and mechanisms to integrate** outside knowledge into the internal knowledge base (based on experiences within the regions).

Territorial Knowledge Management (TKM) aims to **shorten the time of innovation**, to increase the speed of productivity increase and to **promote spin-off of innovative firms**.

THE STEERING OF INNOVATION NETWORKS IN LOCAL SECTORAL CLUSTERS

THROUGH KNOWLEDGE MANAGEMENT METHODS TO FOSTER ENTREPRENEURSHIP IN INNOVATIVE FIRMS



Phase 1: Knowledge Management system analysis:

* analysis of 1-2 **historical cases of innovation** in the network of the firms belonging to the selected cluster,
* analysis and understanding of the existing networks and infrastructure, description of the various **complementary networks** existing in the cluster considered and identification of the elements of the value chain,
* audit existing knowledge assets in the cluster considered, mapping networks of experts and identification and formal description of the explicit and tacit **technological competencies existing within the firms** of the cluster,
* definition of the technical characteristics of a **repository/data base** and codification of tacit knowledge and competencies,

Phase 2:Knowledge Management system organization and development:

* definition of the **problems** and of strategic objectives of the firms and align knowledge management and business strategy,
* identification and removal of the **obstacles to the integration** of the various actors within the various networks in the selected industrial clusters,
* secure a fast and **easy access to the various knowledge and competencies** organized in the procedures of “knowledge management”,
* **creation of knowledge management hard and soft infrastructures** and redesign of the organizational processes and of the procedures of connectivity between the actors,

* design the knowledge management team and **continuous training** of workers aiming to enhance existing internal competencies and knowledge, to increase the **receptivity to innovation** and to develop new specialized competencies
* **creation of financial incentives** to the partners of the joint project, protection of the **intellectual property rights,** managing the reward structures and leveraging intellectual assets,

Phase 3 Knowledge deployment, value creation and innovation:

* driving knowledge generation for innovation and definition of **an innovative industrial project** shared by the various firms,
* **scanning technology opportunities, technology foresight** and identification of the technologies required for overcoming the critical factors of the firms,
* **promote the openness of the networks to national and international actors** and development of new collaborations,
* understanding and measuring the value of knowledge, **evaluate performance** and **refine the KM system**.

Learning and innovation processes are all embedded in a given institutional context as also suggested by the studies on the technological systems and on the national innovation systems, that underline the role of the institutional aspects (Lundvall 1992, Nelson 1993).

For this process of networking to develop efficiently, some **"enabling structures"** both material (ICT) and immaterial (intermediate institutions, service centers, agencies, technological transfer centers) should be in place. Therefore the need does emerge to create specific **"intermediate institutions" with the task of integrating the know-how** of the individual sectors and of **assuring a unitary, albeit non hierarchical or network based, governance of the processes of information circulation and strategic decision-making**, aiming to the improvement of the production processes, as well as of the typical products of the local production system under consideration.

In this perspective the **universities,** the different vocational training institutions and the professional communities, that share similar professional profiles active at the local level, become the natural candidates to act as interfaces or as gateways between the set of the firms operating in the local production system and the international network of knowledge production and diffusion.

In fact, according to the **Communication of the EU Commission to** the Council of Europe and to the European Parliament entitled "Innovation in a knowledge-based economy (2000)", "in addition to their traditional role in the **fields of education and research**, universities should have a **third mission**, i.e. that of **promoting the diffusion of knowledge and technologies**, above all amongst local entrepreneurs".

Different concepts of distance and different forms of international integration

A network model illustrate that distance plays an important role in explaining the different effects of the process of international integration or of the globalization process on the regional economic development.

In this perspective it seems useful to adopt the distinction between **two concepts of distance**:

*** "geographical distance",**
*** "organizational/ institutional distance"**

Geographical distance is less important as an obstacle to international co-operation, when the organizational or technological distance is limited.

The joint consideration of these two concepts may allow to illustrate **four different cases of international and interregional integration.**

In general, **a low geographical distance** allows a tight **production integration,** like in the JIT or outsourcing production methods

On the other hand, **a low institutional/organizational distance** allows tight forms of **financial and technological integration between contiguous regions,** like between many HT firms at the world level.

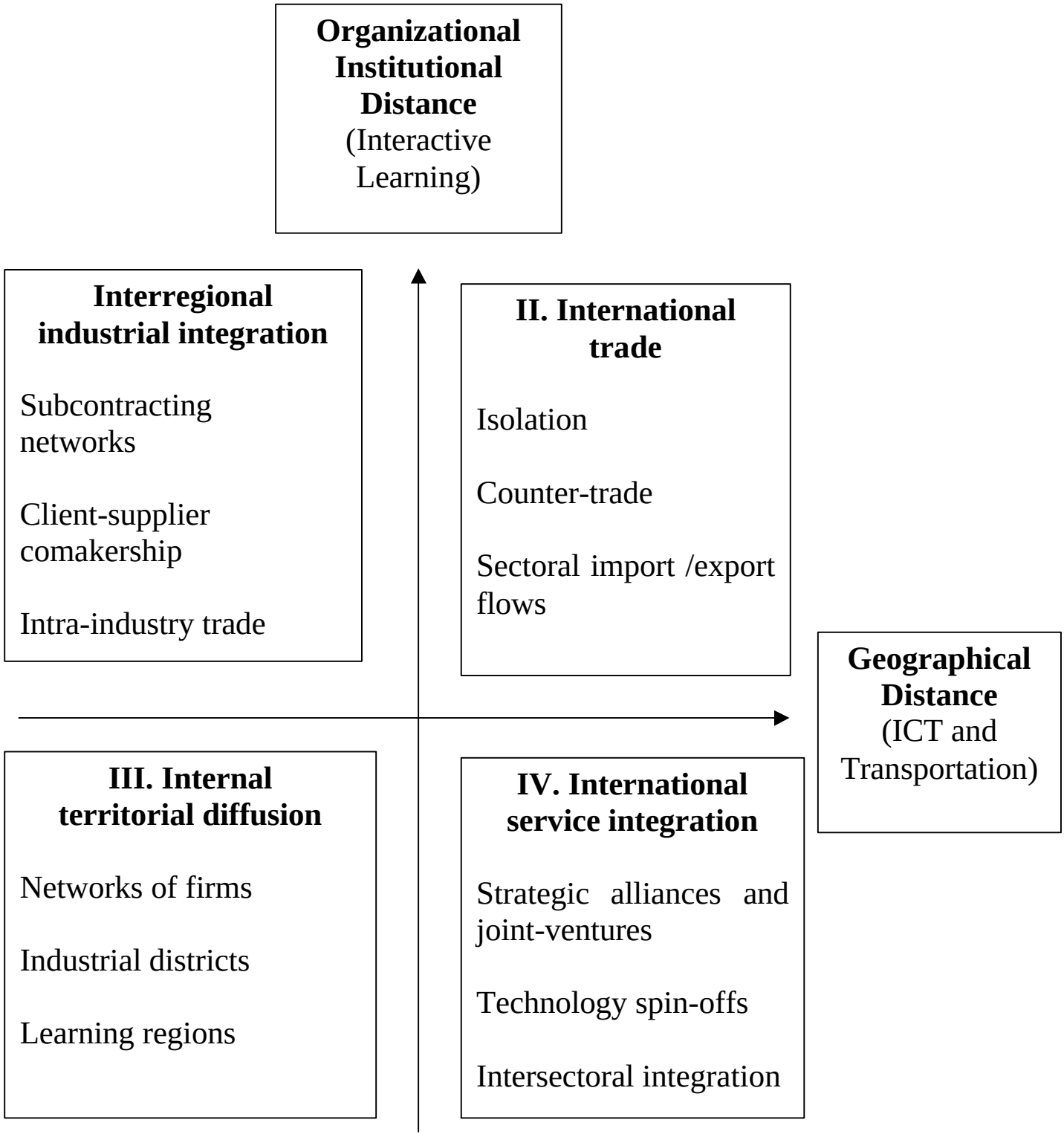


Figure 3: Concepts of distance and forms of interregional-international integration

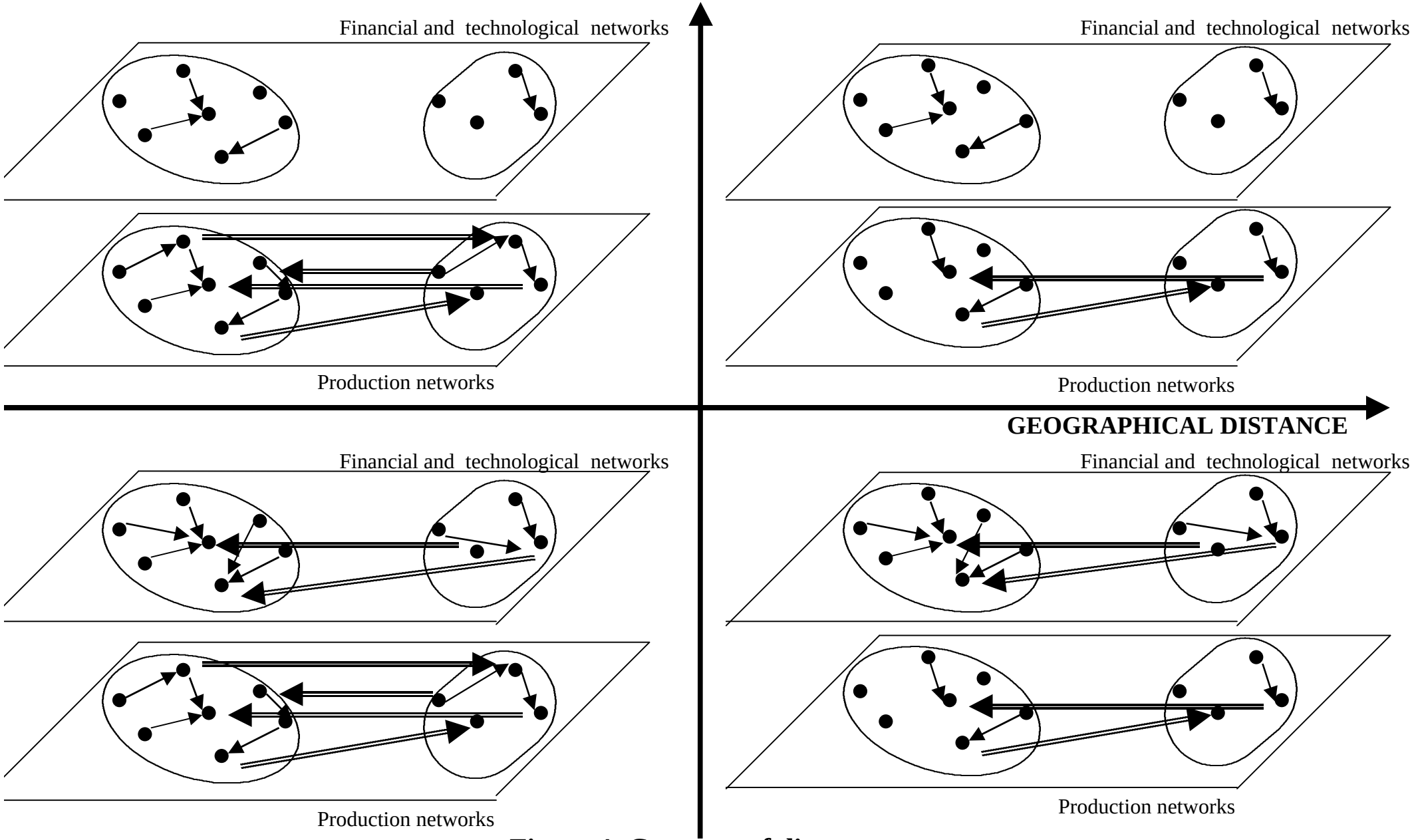


Figure 4: Concepts of distance and forms of interregional-international

The interaction between the regional policy and the enlargement policy

The impact on the **economic lagging regions in Southern Europe** of the enlargement of the European Union toward **Central and Eastern Europe** may be analyzed according to this model of the forms of international integration.

In particular, the relationships between the **two European "macro-regions"** (Southern Europe and Central and Eastern Europe) are often interpreted according to a **competitive approach**, where the lower labor costs in the new accessing countries would attract foreign capital investments and thus reduce the development potential in the economic lagging regions in Southern Europe.

On the contrary, a direct competition between these two European "macro-regions" may not arise or may be rather limited. In fact, there are **profound economic differences** between the regions in the accessing countries in East and Central Europe and the regions in Southern Europe.

That may be illustrated with the model indicated before, where the accessing countries may be located in the quadrant II, where both the geographical and the organizational/institutional distance are high. On the contrary, the economic lagging regions of the actual EU member countries may be located in an intermediate position, closer to the quadrant I or the quadrant IV.

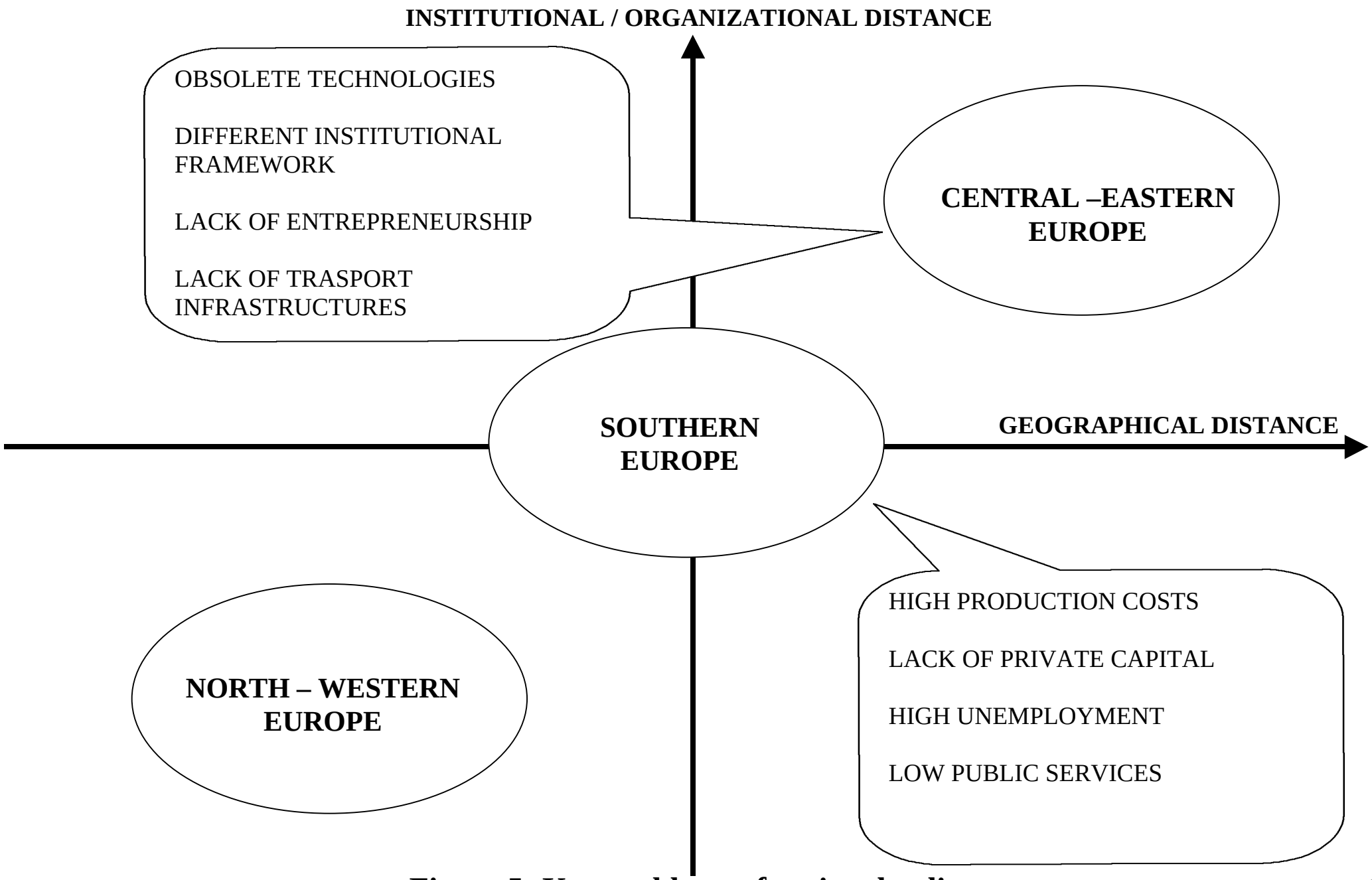


Figure 5: Key problems of regional policy in two European macro-regions

On the other side, the **traditional measures of regional policy adopted in the economic lagging regions** of the actual EU member countries, such as for example

*** financial subsidies** to private investment,

* the decrease of production costs through **lower taxes on labor costs or lower wages**,

* the transfer of **public finances to local authorities,**

have been developed on the base of the priorities of the mainly rural, non industrialized regions in Southern Europe. They little correspond to the actual problems of the accessing countries.

They would even **create conflicts** with respect to the policies aiming to:
* macroeconomic convergence,
* microeconomic integration,
as they would **slow down the process of industrial restructuring and increase the public expenditure and deficits in the accessing countries**.

On the contrary, **the most appropriate objectives for an European policy** addressed to promote a long term selfsustained development **in the Central and East Europe countries** seems to be:

* modernize the institutional system,

* promote a tighter economic and institutional integration of the firms and the public institutions of these countries with similar firms and institutions in the actual EU member countries.

* promote the technological and organizational change,

* increase the productivity of the industrial system,

Thus, **the most appropriate form of regional policy** in the Central and East European countries is not

* the transfer of financial resources *per se*,

but rather

* to promote the gradual adoption of the Community regulations (represented by the 31 chapters of negotiation, which represent the so called “Community acquis”) and to promote a tighter integration with the other EU countries in a technological, financial, social and institutional perspective.

Conclusions:

International economic integration is a multidimensional concept, as it implies:

*** market integration**, which facilitates the integration of the flows of products/services and it is determined by custom tariffs, common currency, transport, ICT and other monetary barriers
*** institutional/organizational integration**, which facilitates the international integration of the:
- flows of investments,
- flows of labor force,
- flows of technological knowledge
- social links
- cultural links
- institutional links

as all these flows require an harmonization of the organizational and institutional framework.

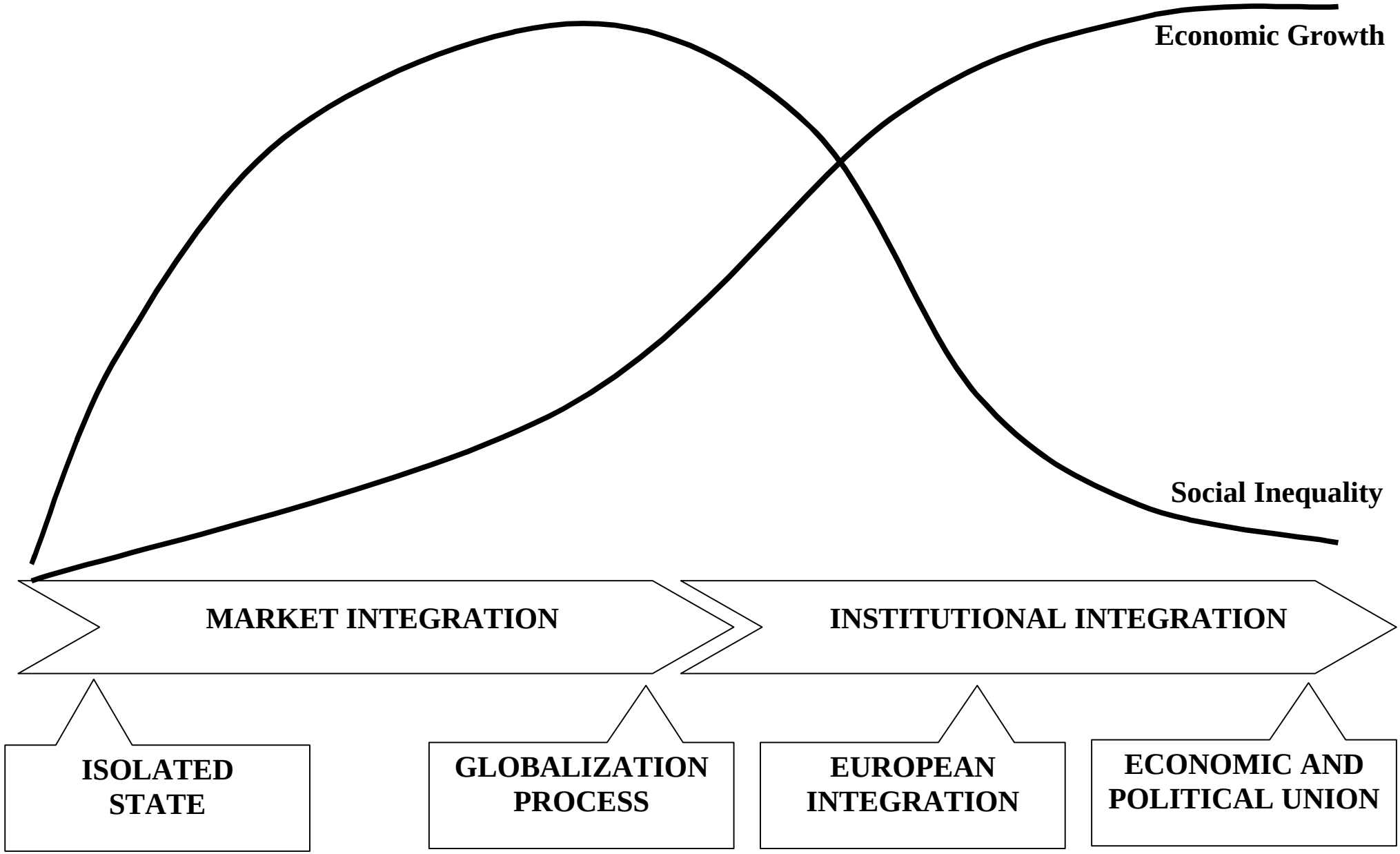


Figure 6: Forms of international integration and the trade-off between growth and inequality