Innovation and competitiveness in the information society

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Key terms in innovation and R&D

1. The omnipresent innovation

In the information society, acquiring and producing new information and knowledge are of ultimate importance in the life of a given community or organisation, whether it is a country, a company, a settlement, a region, an educational or research institution. This chapter does not deal with the questions of individual knowledge and individual competences since information management and knowledge management are currently at a level where global competitiveness requires teamwork, i.e. the co-operation of a group of qualified people. In the information society development focuses on a novel way of joining together and applying existing information and knowledge as well as producing new information and knowledge. **Innovation** is the umbrella term used for the activities aimed at realising these processes.

This chapter will deal with:

- the various basic types of innovation in profit-oriented organisations;
- the extent to which the production of new knowledge and skills is linked to science;
- the relationship between innovation and the economic competitiveness of companies, countries and regions;
- the actors through which information and communication technologies influence innovation processes in the information society.

A distinction should be made between smaller- and larger-scale innovation, the previous being called "small innovation", which is referred to by different authors as "sustaining", "linear", "occurring during production or use", "leading to the gradual accumulation of variations" and "incremental". Such innovation can be realised by using existing competences to make minor improvements; thus, it is like a crossword where we know that there is a solution to the problem and we have a more or less vague idea as to its nature, with the only task being to define the exact path that leads to that solution. In contrast, so-called "big innovation" opens up radically new paths. It includes the element of "original surprise" in that even in the moment of its realisation it is not obvious what potentials it will offer when it is eventually implemented. Thus, the shift in direction that is involved in such innovation is conveyed by attributes such as "breakthrough", "radical", "non-continuous", "non-linear", "disruptive" and "architectural". In other words, the foundation of great innovation is not the refinement of already existent paths.

The main aim of this chapter to examine how the different types of innovation employed by different actors affect the economic performance and competitiveness of a given, delineated community or organisation in an age where we can talk about the mutual evolution (co-evolution) of infocommunication tools and societal existence. The first difficulty we face in this chapter is that actors are hard to define: competition takes place globally as well as at the level of greater regions and countries while we can also talk about specific profit-oriented and non-profit organisations as well as regional and national innovation systems. Furthermore, the scientific researchers, who are the primary contributors of great innovation, more often function as part of a global scientific sphere than as part of a national economy; therefore, in an economic sense their contribution can be utilised at any geographical location.

In the age of the information society, innovation is not a particular, localised activity but arises from our natural, universal need to adapt. In modern times the world has become increasingly knowable and the opportunities for innovation have kept pace with the need to innovate. Once it became possible to encode information in digital form and thence transmit it, *the gathering, arrangement and processing of information has become much easier as has the potential to collaborate in these activities.* At the same time, improvements in the efficacy and power of infocommunication tools, as well as variations in our competence to exploit them, have resulted in significant differences in innovation performance.

In this chapter the concepts of innovation and *competitiveness* are dealt with mainly in an economic context. *The last two decades have brought a significant shift in scientific discourse: the concept of innovation has undergone significant reinterpretation since if social and economic processes are viewed in the context of the information society and the knowledge-based economy, the importance of innovation performance becomes more obvious and perceptible.* The significance of innovation, used in an increasingly wider sense, has been recognised by political decision-makers; thus, this topic has become more of a focus in strategic development. It is therefore essential that the role played by states and other government levels (primarily regions) should be discussed in this chapter, since the activities of these actors are aimed at improving the environment for economic development where the enhancement of innovativity has utmost significance.

2. Types of innovation

The concept of innovation has broadened in the last decade, as new ideas that facilitate business success have been gradually explored and changes have been made. Besides product and process innovation, scholarly literature has increasingly identified themes such as marketing innovation and organisational innovation: *"An innovation is the implementation of a new or significantly improved product (goods or services), or process, a new marketing method, or a new organizational method in business practices, workplace organisation or external relations"* (OECD, 2005). While earlier attempts at defining the concept of innovation were almost exclusively limited to the invention and the technical implementation of a product and the improvement of the production process, this new definition is applicable to more than just technologies.

Product innovation is the implementation of a new or significantly improved product or service. **Process innovation** means the implementation of a new or significantly improved production or delivery method, and involves new ideas of a technological nature. **Marketing innovation** is the development of new marketing methods with improvement in product design or packaging, product promotion or pricing. **Organisational innovation** involves the implementation of new organisational methods in business practices, work organisation or external relations.

Why is non-technological innovation important? The creation of a new product always involves large amounts of resources: qualified and creative manpower as well as a broadly understood research and an R&D infrastructure. The steps taken are becoming more and more deliberate since it cannot be left to blind chance what the outcome of our innovations will be. Thus, nowadays the concept of innovation almost always means conscious innovation. Decisions need to be made about the investment of resources - but what is *an intellectual product* worth before it becomes material goods or an implemented service, or a process that facilitates the creation of both? What is an intellectual product worth when only its creators and some scientific researchers or development engineers understand its significance or operation? There is great level of risk linked to *an innovation since it has no financial value up to the moment when it reaches the stage of being introduced to the market.* Technological advances in the economy represent no value by themselves since it is the customer who passes the final verdict on their actual financial value. For example, the benefits of groundbreaking solutions cannot be demonstrated in carefully written analyses and studies since what is needed is for the new solution to be tested on the market. Naturally, *an innovation can only be regarded as successful if its outcome will bring financial advantage to its owners and users in the market place.* The manufacturing of a product might be made cheaper (by improving the process) and a new product or service might be successfully launched on the market; however, these same objectives are pursued by a lot of competitors. What can be seen is that some products will be sought after while others will remain almost unnoticed; this is when the importance of marketing innovation comes into focus.

Let us imagine that two companies launch their functionally identical products on the market at exactly the same time. Market demand is created through a marketing activity for a product that previously seemed to have weak sales potential. Carefully conducted market research can result in more successful product design as well as more efficient and complex advertising. The company that implements this can realise greater sales or build a more prestigious brand name. In this way the same product can be sold at a higher price in relation to the production cost; thus, the rate of profit is higher than in the case of the rival company that launched the same product but used no marketing activity. Moreover, marketing enables a more accurate identification of the product's target group and customer base, which can then be reached much more easily when subsequent innovations are made. *In other words, the significance of innovation in the sales area has increased.* Infocommunication tools and media convergence play a prominent role in this change: due to the exponential growth and increasing accessibility of advertising, entertainment and other similar contents, it is becoming increasingly difficult to attract the attention of individuals, companies and public institutions (as consumers). *It is no longer enough to manufacture a good product since it must be marketed fast and efficiently.*

The significance of organisational innovation is easy to understand: for example, manufacturing processes can be made cheaper if the number of employees is smaller, or if the work is carried out more efficiently. If the labour force is recruited more effectively, it might result in enhanced productivity. If a stimulating environment is created in the workplace, the information flow between colleagues will speed up, which can result in more new ideas and faster problem solving. If the individual (even informal) knowledge of all the members of an organisation is arranged into a clear portfolio, the right person for the right job is easier to find.

Innovation and adaptation

Scholarly literature focuses on the concept of innovation whenever the theme of producing new information and knowledge is discussed. In the past it was the sphere of science that was regarded as being the driver of economic and societal transformation. However, abstract knowledge does not have a direct impact on everyday life and does not necessarily result in economic competitiveness. A good example is the Soviet Union, which had a technological and scientific performance of a world standard but at the same time poor economic performance, leading to the subsequent collapse of the country's entire economy. Today innovation is often understood as the later stages of creating and marketing a new product, service or process, primarily linked to companies. This is also reflected by the standpoint of the experts commissioned by the OECD: *"Innovation is the transformation of an idea into a new or improved product launched onto the market, or into a new or developed method used in the industry and commerce, or a new approach taken to some social service"* (OECD, 1994: 19).

In this approach innovation does not include the concept of research and development[1] which provides users with explicit knowledge prior to innovation and which is systematic knowledge that generates further knowledge. "***Research and Development*** *(R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge of man, culture and society and the use of this stock of knowledge to devise new applications. R&D is a term covering three activities: basic research, applied research and experimental development.*" (OECD, 1994: 29).

[1] There is another trend as well, according to which the concept of innovation does not only include research and development but all planned (and at times accidental or ad hoc) renewal and adaptation processes and phenomena. In the information society the system of institutions, culture and individuals must be ready to learn.

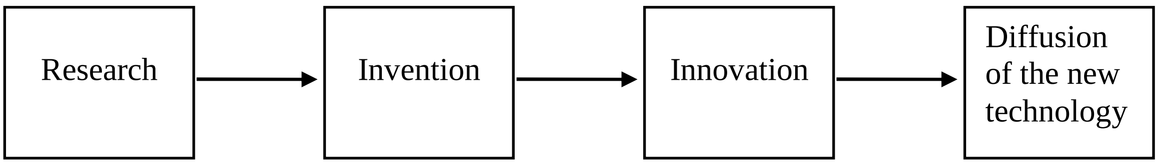
If the definition of innovation given by OECD is interpreted with the intention of generalisation, it can be said that innovation comes into being as a result of R+D and/or the flow of technology. According to Kirkland, ***technology transfer*** *is the process during which ideas and techniques generated in one area are applied in another area.* As has already been mentioned, scientific achievements as well as realisations and inventions created with non-scientific methods are only as valuable as they are applicable. This means that an intellectual product must be described and presented in a way that people apart from the inventor would also be able to understand the exact operation and all essential features of the material product, service or process that can be created from this intellectual product and thus they would be able to compare it with similar products, services and processes they are familiar with; i.e. scientific knowledge must be converted into technological knowledge in order to ensure its marketability. *Technological knowledge makes recognisable and applicable packages of various techniques that are designed to accomplish certain objectives.*

Scientific and engineering knowledge are equally important in the framework of producing and exploiting new technologies. In areas where such skills are available, there is a natural tendency to obtain or reconstruct knowledge that was created elsewhere. The ability to adapt and apply existing knowledge is of paramount importance and is hard to differentiate it from the process of producing new knowledge and technologies: *in fact, adaptation is the recreation of an innovation performance. Those actors that are the first in applying new information and knowledge have the greatest advantage.* However, application requires an adequate legal and institutional background, a qualified workforce, the ability of various actors to co-operate, as well as financial capital that can be accessed fast and flexibly. These factors will be discussed in detail at a later stage.

Various innovation chain models

At first innovation was modelled as a linear process: it was considered to be a sequential activity. The starting point in this model was the new achievement of *basic science*, which researchers then have to convert into applied scientific results. These results no longer represent abstract knowledge but mark the framework in which scientific knowledge is worthwhile and applicable. From this point onwards the results of *applied science* serve as a basis for developing new products, services and processes. These early development phases can be carried out equally by a company or a scientific research team. However, the next phases are dominated by profit-oriented companies, since the new product needs to be adapted to market conditions: the target group for the given product, service or process needs to be exactly defined; and decisions need to be made about the design that most suitably matches the company's image and the product's functionality. The costs of manufacturing the product and of positioning it in market must be calculated, as well as the expected business outcome.

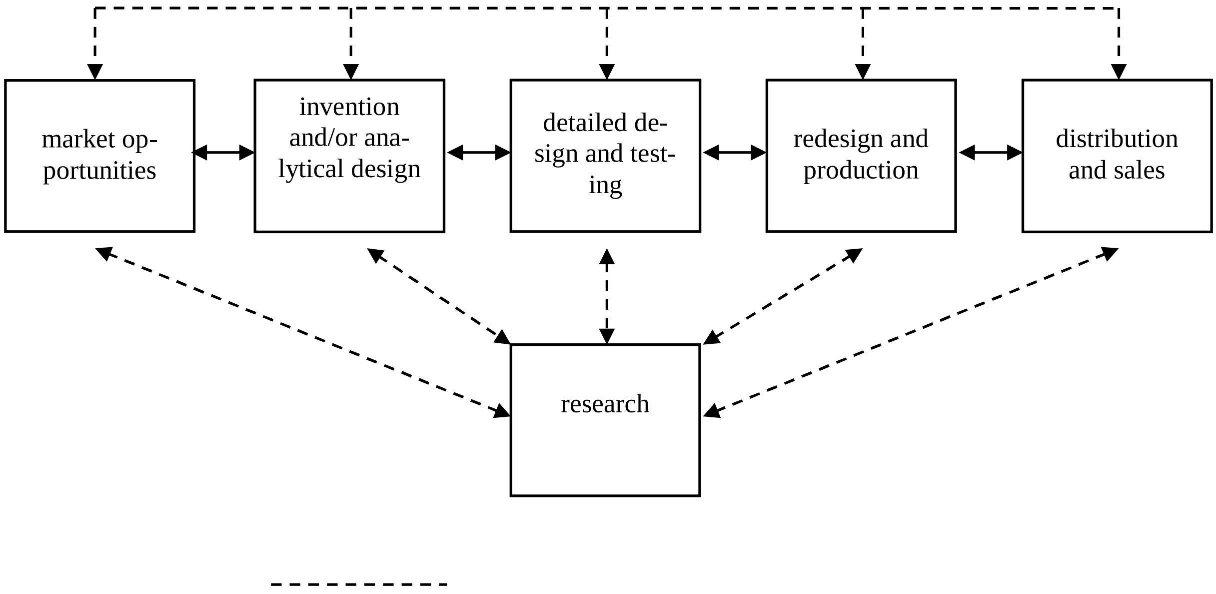
1. Figure: Linear model of the innovation process



Source: Borsi, 2004: 9

This linear model of innovation resembles technical processes and ignores a lot of important factors. In the linear model, diffusion, or spreading, begins with the purchase, copying, parallel discovery, etc. of a technology or product, in other words, with its marketisation. In the same model a technology shift occurs when a marketised and more or less diffused innovation is no longer needed, i.e. a substitute innovation starts spreading.

2. Figure: The link-chain model of innovation diffusion (knowledge flow)



Source: Borsi, 2004: 10

The concept of the link-chain model was created by Kline and Rosenberg (Kline-Rosenberg, 1986). *In the link-chain model, businesses recognise product ideas as a result of market- and/or other factors and they test elaborated product designs based on these ideas; the approved product version is then launched onto the market after several steps of correction.* Accordingly, this is not a one-way process since *in order to overcome the difficulties that arise during the development process it is often necessary to return to the previous phases.* There is a constant feedback between different parts of the process. The success of the innovation in this case depends on how efficiently companies are able to establish and maintain the interaction between the phases of the innovation process. It is important to point out that according to the link-chain model, the market virtually forces innovation out, i.e. the market is not "pulled" by the impetus of the scientific-technological development.

If we examine innovation from the perspective of businesses, it becomes clear that *innovation appears as an investment issue at each point of a company's activity: it acts in the hope of achieving success on the market and this remains its main point of orientation during the decision-making process.* Technological breakthrough most often occurs outside of companies, which means that *the primary task of companies is to recognise those scientific and engineering results which they can convert into market success in time and at a reasonable cost. In this case innovation is a conscious striving determined by the identification of market needs and by companies' strategic plans.*

In contrast with the linear model of the innovation process, the link-chain model and even the *closed innovation chain model* call attention to the importance of ensuring interaction and flow between each of the phases in order for the innovation to retain its dynamics. In a large number of cases scientific research is not needed for the development of a new product or process. Technologies required for the creation of a product, service or process can also be purchased. A product technology is converted into successful sales by one company but not another. It is possible that only the marketing strategy needs to be changed in order to achieve success, but perhaps larger amounts of capital are required to successfully exploit a given technology than are available to the company that owns and applies the given technology. Furthermore, it may be the case that changes in work practices during the manufacturing process will eventually result in a reduction of the product's price and a previously unsuccessful innovation will become successful on the market. This means that one innovation can be made economically successful by another innovation. What is more, the success of innovation activity can be affected by events that fall outside the scope of science. For example, a market liberalisation process, i.e. the legislative activity of the state aimed at doing away with and preventing market monopolies will make smaller actors interested in pursuing innovation activities and will thus facilitate the market success of new, innovative products and services.

To sum up, innovation is a complex and complicated process, involving among other things *the multiple interactions between available research results, market opportunities, abilities and strategies*. The various elements of the innovation process do not follow each other in a linear succession but, depending on the nature of a given innovation, may run parallel with each other and in some cases not all the elements participate in the innovation process.

1. The relationship between infocommunication technologies and scientific research

The use of *infocommunication technologies* has exerted a significant influence on innovation processes and on the underlying scientific research; however, this impact cannot be expressed in numbers exactly. The immense capacity for calculation introduced by the computer brought about new results in some areas of basic science. For example, the most recent results in astronomy, in aviation research and in molecular biology would be hard to imagine without the existence of informatics. There are no longer any areas that are unaffected at least to some degree by informatics. The coupling of informatics with other disciplines has led to the emergence of new interdisciplinary, transdisciplinary or multidisciplinary sciences (e.g. bioinformatics). In addition, ICT has played an indisputable role in the invigoration of relationships in international science since even research teams that are physically far away from each other are now able to co-operate with each other on a daily basis.

1. Table: Sectoral breakdown of the R+D expenditure in the biggest companies in and outside Europe

	The 500 biggest companies in the EU		The 500 biggest companies outside the EU	
	R+D investment in the given sector expressed as a percentage of the R+D investment in all the sectors	R+D expenditure as a percentage of income from sales	R+D investment in the given sector expressed as a percentage of the R+D investment in all the sectors	R+D expenditure as a percentage of income from sales
Automobile and automobile parts	23.8	4.6	15.7	4.1
Pharmaceuticals and biotechnology	17.0	15.2	18.5	15.1
IT hardware	12.4	15.6	22.9	8.6
Electronics and electronic equipment	10.3	6.5	10.9	5.7
Chemical industry	7.2	4.2	4.2	3.8
Space technology and defence industry	6.8	8.0	2.1	2.7

Engineering industry	4.6	2.5	2.5	2.8
Telecommunication services	2.8	1.0	2.0	2.5
Software and computer services	2.6	12.8	7.8	10.0
Oil- and gas industry	1.9	0.3	1.2	0.5
All the other 21 sectors together	10.6	1.5	12.2	2.1
All the 31 sectors	100.0	3.2	100.0	4.5

Source: European Commission, 2007: 6

The leading areas of science that experience groundbreaking progress in a given period clearly induce the intense competition of technological development. The most innovative industrial and service sectors have the closest links with those areas of science in which the use of ICT generated a sudden leap in development: out of the 500 biggest companies of the world it is the companies active in the area of services based on pharmaceutics, biotechnology, IT hardware, software and computer services that are forced to invest the most in R+D in order to maintain and improve their market position. These companies typically spend over 10% of their income from sales on research and development.

2. The relationship between infocommunication technology and innovation

The most significant national commissions for scientific research and development throughout the modern era were given primarily at times of preparing for war. Governments were behind infrastructural developments since through these they could maintain a certain control over the population. Mass education was thus a tool in creating people with predictable and controllable personalities.[2] *Institutions of higher education and academies in Europe were indeed centres of knowledge; however, they rarely formed ties of co-operation with businesses during the emergence and the flourishing of the capitalist economy (in the 18-19th century).* They were places of learning available for the key players of the new socio-economic order (as individuals) but they were independent and separate entities and had ties only with the state, which acted as a patron or commissioner of research. Businesses at the time were often established based on an inventor's[3] idea or managed to flourish by benefiting from the individual performance of some creative engineers. The improvement in transport and transportation infrastructure and the increasingly globalised competition provided the opportunity for the advantages gained in technologies to be exploited by business.

In countries with adequate capital concentration, the protection of intellectual property rights and a less regulated market attitude were ensured and the relationship between "knowledge producers" and "knowledge appliers" was stimulated, resulting in a competitive advantage that is perceptible even today. However, *research work conducted on commission directly by the state and directly or indirectly serving the purposes of the army were characteristic of this period.* Even companies that carried out scientific research and development activity received commissions mostly from the military: the robust development of some business giants in the heavy machinery and chemical industries *around the turn of the 19th century* was partly due to this fact. The resulting technological achievements only appeared in the form of civil

[2] Of course, at times the incumbent political leadership used it to facilitate the process of democratisation.
[3] The inventor often did not have formal higher education; a good example for this is the extremely productive inventor, Thomas Alva Edison.

applications with significant, decade-long delays. It can therefore be stated that *the scientific sphere, which is the classical social sub-system of research and development, impacted economic competitiveness only indirectly.*

In Europe, attempts at creating directly applicable knowledge were made to the detriment of the autonomy of universities and academies. In France, for example, Napoleon established colleges to train engineers, and Germany used the same "detour" in order to secure the human knowledge resource that were at the same time practical and built on a scientific foundation. Thus, the complex system of colleges, universities and academies that came into being in Europe did not prove to be as efficient as the institutions of higher education in the United States, where universities were more readily able to respond to the demands of business for organisational and cultural reasons and to access external funds through this channel in addition to state support and commissions for scientific research. Taking advantage of the performance of a highly developed defence industry, the American system exerted a positive influence on economic competitiveness. It is likely that as relationships between universities and businesses expanded, researchers working on military development projects occasionally converted their knowledge to support activities in the non-military business sector.

The gradual development of the money market during the 20th century and primarily after WW II created a new situation. As a general rule, those investing capital want a guarantee that those who use the financial resources placed at their disposal are able to do so successfully, and the best guarantee for this is the creation of an innovative product or service that can be sold on the market or the development of an improvement to a process (production technology) that radically increases their turnover or profits. *In response to this, a new type of enterprise emerged in the developed countries, namely the so-called 'spin-offs', which are a common form of technology-intensive start-ups and built on results achieved mostly by university researchers and which can be exploited by business.* Similarly to technology-intensive start-ups in general, the main asset of these small businesses is the innovativeness they demonstrate in product and service development, although they need access to capital investment (so called '*venture capital*') on terms more favourable than traditional credit, as well as experience in corporate management and especially in marketing in order to optimally exploit their potential.

All these key factors and the emergence of the digital world mutually influence each other. *In short, ICT use impacts innovation directly or indirectly in the following ways:*

- *entirely new scientific performance is achieved through the expansion of computing capacity and informatics in general;*
- *the enrichment of scientific discourse and better availability of information enhances the creation and availability of new knowledge and thus activities related to its application and exploitation;*
- *ICT use facilitates technology transfer;*
- *work organization in companies and communication with business partners are made more transparent and rational; complex corporate management systems emerge; performance monitoring, quality assurance and other management solutions are easier to control;.*
- *the new generation of machines stimulated the technology race; robotics appeared in industrial manufacturing and from now on the most important "labour" is the programmed machine which needs to be constantly improved;*
- *innovation cycles become shorter, while the technology shift becomes faster;*
- *the development of a global, "real time" money market facilitates the transfer of technologies and broadens the field for venture capital; at the same time, the money market has become very sensitive to technological competitiveness;*
- *ICT enables and necessitates the fostering of dynamic relationships between key actors (research institutes, companies, local- and central government).*

The role of R+D and ICT in economic competitiveness

Whether we examine the relationship between productivity and R+D or that between productivity and ICT we are facing a difficult situation. In theory the correlation seems clear. On the one hand, it can be said that if the performance of scientific R+D engineers is of a high standard, it leads to new technologies, and new technologies enhance productivity. On the other hand, the use of infocommunication technologies facilitates the better organisation of work and the better management of business relationships; moreover, ICT is used in new generation machines and thereby contributes to increased productivity. However, when examining what indicators should be used to measure the above three factors, the relations between them are more than hard to argue.

Productivity is measured as the output per work hour or worker, or per unit of invested capital. Output is basically defined as the gross value of market sales. However, the closed innovation chain model reveals that market success is more closely related to the recognition of a scientific-technological breakthrough and the ability to apply it practically than to the scientific performance of the country where the user of a technology operates. In the next section of this chapter it will be demonstrated that *a company may outsource research and development activity to R+D institutions based in economically less developed countries*. The fact that R+D performance is primarily measured by the resources invested in it causes an additional problem when examining the relationship between R+D and productivity[4]. Experience shows that developed countries have spent large amounts on research and development for a longer time and in the majority of cases it is the companies that contribute the greater proportion of research and development expenditure. *On the whole, the correlation between research and development and productivity is significant but is increasingly regarded as being indirect.*

It was Manuel Castells who examined the relationship between the appearance and application of ICT technologies and productivity (Castells, 1996), and his discoveries are still valid today. During his investigation he faced the following problem: when productivity was measured with what we can now call a more traditional method, it showed that between the 1970s and the 1990s the rate of increase in productivity halted at the centre of economic-technological development, despite the fact that the use of ICT became more intense during this time. The total productivity index measured in countries with the strongest economies was also stagnating (United States, Canada) or showed an increase of only 1-2%. Japan was the only one during this period where the pace of growth did not increase but it did not decrease either (1.3-1.4%). Furthermore, hardly any advancement was detectable in the service sector (where ICT can be most directly utilised). One of the reasons for this might be that there was a delay in the increase of economic productivity in relation to the appearance of technological innovations. This is well demonstrated by the fact that the highest productivity growth rates (2-9% annually) were measured in the most competitive economies between 1950 and 1973, when the technological innovations made during World War II primarily restructured industrial production, most certainly played an important part.

In his work *The Rise of the Network Society* Castells arrived at a clear conclusion: "*In order for technological discoveries to permeate the entire economy and thus enhance the growth of productivity in a perceptible way, all factors of the production process, the culture and institutions of society and, naturally, economic enterprise must undergo significant changes. This general statement is especially valid in the case of the technological revolution, which is centred around knowledge and information and which*

[4] Because of the difficulty in determining the value of an intellectual product, which we mentioned earlier on.

is embodied in symbol processing manipulations that are perforce connected to the culture of society as well as the level of education and professional qualifications of the population."

Castells and other leading economists also faced the dilemma that the methods of measurement they applied did not adequately map the structural changes in the information society, since in an indirect way they did not take account of information processing operations. If the service sector is examined industry by industry, significant productivity growth can be seen in those cases where the impact of ICT on performance is theoretically expected to occur the soonest: telecommunication, rail and air transport and transportation showed an annual rate of 4.5-6.8% productivity growth in the United States between 1970 and 1983.

The relationships between productivity and ICT and between productivity and R+D reveal that the closed innovation chain model can be regarded as a valid description. At the same time, it can also be seen that significant success can be achieved by using starkly different strategies at the level of companies and of national economies alike. *What appears to be a shared characteristic between successful practices is* that they all involve varied and dynamic relationships. *In these practices flexible and robust networks are established with different actors* (research and development bases, governments, small- and medium-size businesses, innovative start-ups, private investors) *in order to facilitate the diversity of business activities* (supply chain management, organisational information and knowledge management, production technology development, market sales, etc.). Some of the connections are vertical, in which case the profile of the network is determined by a powerful company and the other actors function as its suppliers. Today there are, however, an increasing number of networks built on horizontal connections, especially in Europe. In these networks the more or less permanent members are almost equally powerful and typically operate in the same industry. Horizontal connections are mostly locally embedded and are suitable for achieving significant cost savings (by joint acquisition of raw materials and joint product delivery and sales). Joint innovations of strategic importance are less widespread; however, large-scale actors – mostly big corporations acting upon government initiatives – show an increased willingness to participate in such ventures.

1. Division of labour in R+D across the globe

Since the early 1980s companies have increasingly adopted the practice of outsourcing some of their operations in collaborative projects worldwide - a number of research and development projects are also outsourced (design, technological development, research, testing). This involves not only commissioning other local actors (such as institutions of higher education) and utilising infocommunication technologies to facilitate the outsourcing of certain R+D tasks to centres that are far from the company's headquarters. The reason for this is that even the *biggest multinationals do not always have the necessary professional R+D capacity; innovations of strategic importance are better facilitated if development networks are established.* Research and development costs are constantly increasing and this has created the need for co-operation across national boundaries.[5]

Development networks can be horizontal or vertical. In the first case, companies active in the same market, who are thus actually rivals, co-operate with each other and with R+D centres, since it is in their interest, at least temporarily, to work together in order to achieve a technological breakthrough. In such instances the technologies involved are at a so-called pre-competitive stage, i.e. none of the participant companies manage to create a marketable product or service with their technologies.[6] In vertical development networks suppliers

[5] Of course through its subsidiary a multinational company is present in the country where it outsources its R+D activity. This helps with co-ordination and grants easier access to state allowances companies are entitled to if they carry out innovation in the given country.

[6] For example, a company may want to develop the data transfer technology of mobile phone networks in order to be able to provide more complex and more marketable services, or to make wireless data transfer secure. Such development projects may boost the entire sector, enhancing the marketability of mobile telephones and the services they provide many times over.

and buyers are in co-operation with a company. An example for such co-operation is the development of the Boeing 777, where Boeing involved the big airlines in their development work. Representatives of British Airways, All Nippon Airways, Japan Airlines and United Airlines were present from the beginning of the design process to the end of manufacturing. Development ideas created by the airlines helped the manufacturer to develop one of the most marketable aircraft in the world.

Some development networks actually *include both horizontal and vertical elements*. A good example for this is the development of the European Airbus in which a great many European aircraft manufacturers and research institutions worked in co-operation. A perfect example for how outsourcing works is that in the case both of the Boeing 777 and the Airbus R+D, major development tasks were carried out by the development engineers of the Russian Sukhoi, Ilyushin and Tupolev companies. *As a result of co-operation the production development cycle is shorter, parallel efforts are reduced and no surplus information is accumulated. Vertical and horizontal co-operation is facilitated by infocommunication technologies: thanks to the software used in design (computer-aided design (CAD) systems) the partners in co-operation are able to maintain a common development environment without being limited by geographical boundaries. This can be viewed even by (potential) buyers and each stage of the process can be accurately monitored by the project's participants. Moreover, ICT enables companies to receive up-to-date information about customers' tastes and product-related problems.*

Companies have begun to think "without borders" more and more when it comes to making decisions about the geographical locations of their research and development activities and they have stopped insisting on these activities being carried out in their respective home countries. Despite occasional failures, *"research and development is realised in the framework of international co-operation, the necessary capacities for which are gathered from various parts of the world with costs and commercial risks shared between countries and regions and adaptation to specific local conditions dealt with in local organisations"* (Bőgel, 2006: 81).

2. Intellectual property rights: help or hindrance to innovation?

Although the subject of this chapter does not directly involve the issues of *intellectual property rights*, their impact on innovation should be briefly touched upon. Throughout history the special practice – originating from Europe – of ensuring legal protection for intellectual products has stimulated innovation. It was in 1474 in the Republic of Venice that the first *patent law* was adopted, and this practise was followed in England in 1624. *The legal protection of an intellectual product*[7] *which was deemed original or a novelty meant prestige for the lawful owner of the intellectual product and made it possible for inventors, innovators and scientists to form a fair relationship with those interested in the business utilisation of such intellectual products.* Thus, creative men (at least in theory) could not be stripped of the financial gain from their valuable performance and were thus encouraged to come up with new inventions and their registration even if they personally did not have the opportunity to convert their intellectual product into a marketable products. The door was open for them to sell their knowledge to wealthier people.[8]

Before the adoption of patent laws Europe (and later North America) the only way for creative professionals to achieve success was by participating in government development projects. Naturally, *innovation has always played a part in achieving market success, and at times in winning social respect; however, until recently it was all done solely by the manufacturer craftsman.* European universities, which were considered to be capitals of knowledge, did not have any definite or directly stimulating effect on economic development. In contrast, a lot of artisans at the

[7] Its most frequent forms in different legal environments include patents, protected brand names and copyright on design.

[8] In the modern world the role of the customer has been taken over by organisations with legal personalities; however, in the 17-18th centuries we can only talk about merchant-tradesmen.

time introduced innovations for their own benefit.[9] In this way technological development in Europe maintained a relatively unbroken path throughout various historical periods. In contrast, societal relations solidified, starting from the late phase of antiquity, when the flow of knowledge and the turnover of goods subsided and opportunities of free people to exercise their rights were weakened.

Intellectual property rights can provide efficient protection for products that can be fully described with all their particular details recordable in a design and in text. The decision-makers in the competent patent office must be able to understand the essence of the intellectual product and they must be able to compare it with other similar intellectual products. This requirement has *had a stimulating influence on the development of highly standardised engineering designs and terminology.* Countless inventions and innovations have been recorded and systematic techniques developed to document the emergence of technologies. Engineering professions and engineering sciences were developed. *This has laid the foundation for the conversion of intangible information and knowledge into material products.*

It has been pointed out already that the use of infocommunication technologies is especially significant since it facilitates the flow of knowledge formulated in the language of technologies. Technology transfer generates significant business volume: the buying of licenses that enables the use and further development of technologies can amount to as much as 5-10% of total sales, dependent on the industry.

There are numerous theoretical debates and conflicts in connection with the various forms of intellectual property rights. The information society, the acceleration of the information flow and better access to information causes tension in two opposing ways. *On the one hand, the conversion of information and knowledge into products should be appreciated since through this the real owners of knowledge and the most competent users of data and information can gain financial profit*, which is a characteristic feature of a kind of meritocracy. On the other hand, however, *this all happens in a lopsided way in practice since the work of innovative creators may well bring privileges for those who secure strict legal protection for it, which means that in effect those in possession of mobilisable financial capital can build monopolies, using the protection of intellectual property rights as a cover.*

[9] For that matter merchants adopted the Arabic numeric system, developed the system of double-entry book-keeping and the most varied forms of business practices. In addition, being the owners of monopolies they created the foundation for the logistical systems of provisions for armies, which was a powerful innovation. It was not only the state but also shareholding companies specialising in oversees commerce that amply awarded map-makers and expert shipbuilders for their fast improving engineering activities. In England the sudden boom in the development of mining in the 18th century was the result of the gradual expansion in investment opportunities and creative engineering developments occurring simultaneously.

The significance of geographical space today: centres and peripheries in the economy of the information society

As the degree of complexity of products and services rises the competitiveness of a country or a company is fundamentally dependent on how fast and to what extent it is able to acquire new information and new knowledge as well as on how fast it is able to convert this knowledge into marketable products and services. One possible way of acquiring knowledge, information and technologies is "home production"; however, this way cannot be followed on its own due to the specific features of technological innovation (capital intensity, the role of "chance events", the influence exerted by other industries, etc.).

The age of globalisation has brought with it a proliferation of knowledge and technological innovation of unprecedented proportions. In addition to companies' internal research bases, the role played by technology transfer has become more prominent. It can be seen in the closed innovation chain model that openness to innovation is necessary at each phase of business activities. If, for example, the core business of a company is to develop the latest generation of hardware, it is not worth investing in separate R+D teams to develop logistical functions (harmonisation of transportation, warehousing and sales). Competences required to realise these tasks are better purchased. One way to do this is to buy the needed technology ready-made, together with the necessary equipment and training necessary for optimal utilisation. Another possible way – if a customised solution or one that a company wishes to sell on is sought – is to commission a specialist external R+D company.

The optimal way in which a company can achieve a required innovation is determined by the company's management style, the given industry's sectoral structure and the scale of resources (human, financial, technological) that can be mobilised to realise the innovation. An organisation can always enhance its capacity to innovate by using additional R+D capacity, i.e. by co-operation. There is mounting pressure from company managers, who want to see R+D departments making a more direct contribution to business success and for this to be realised not only in the long term. In fact, recognising market demands and technological trends may result in "small innovations" that will be realised in the form of short-term market sales and therefore have a fast turnover rate. Only time will tell what negative effects – if any – the ever-shortening temporal horizons have on the long-term R+D and business competitiveness of companies (see Gupta-Wilemon, 1996). A greater contribution of R+D to business success can only be realised through the greater integration of business and technological strategic planning processes. The role of research directors must also change in such a way that they should not only be in charge of implementing their department's contribution to corporate strategy but also participate in the creation of that strategy.

Speed of development is one of the most important factors of competitiveness. Reducing the time required for developing a new product can primarily be achieved by establishing cross-functional teams[10], the use of CAD systems and the method of concurrent engineering, where product development runs in parallel with production development and the creation of the marketing strategy. This development method could be especially important in those industries where a reduction in the development period plays a decisive role in gaining an advantage on the market. Speed enjoys a high priority primarily in the case of Japanese companies. According to some surveys, Japanese managers are willing to devote twice as much time to speeding up the development process than their American counterparts. Compa-

[10] Permanent or ad hoc teams of employees each having competences in a various department (marketing, development engineer, legal expert, etc.).

nies that can produce high quality products within a shorter time than their competitors will have more room for manoeuvre. For example, if they start the development at the same time as their competitors, they will be able to launch the ready product onto the market much sooner. Alternatively faster companies also have the opportunity to delay the start of the project in order to get more insight into the development of a given market and its consumers. Being faster, they can still launch their product at the same time as their competitors and have it far better adjusted to consumer needs. Another advantage of speed is that they can offer a greater variety to customers and thus better cater to the different demands of various customer segments.

The systems that have been created as a result of the fast development of infocommunication technologies enable companies to enjoy the benefits of decentralisation and centralisation at the same time. For example, integrated information systems between decentralised organisational units make it possible for companies to continue their centralised purchases, i.e. to harmonise their purchases more efficiently than before (e.g. greater quantities can be purchased at a discount price). The creative use of ICT also allows for the parallel operation of decentralisation and integration. One of the basic conditions of both external and internal integration is the possession of useful and accurate information: an organisation (or co-operating organisations) must have relevant data about its (their) own internal state at every single moment. Modern data processing systems (EDI, MRP, the already-mentioned CAD/CAM systems)[11] as well as integrated management information systems are becoming increasingly widely used.

All the foregoing should show that *business actors must be innovative both in the area of developing new technologies and in their company operations*: the latter can bring significant short-term benefits; however, the former is essential in order to achieve long-term success. *At the same time, the successful development of a new technology is greatly dependent on the company's operation.* For example, only those companies that can provide very detailed documentation on their previous business activities are likely to be granted venture capital. Small companies usually have no capacity to do this and a newly established company will not focus on this either. Thus, the most advantageous credit option requires a sophisticated corporate culture as well as innovativity.

There are such differences (qualitative as well as in magnitude) between market actors that small, (uniquely) innovative companies often accept buyout offers proposed to them by globally embedded, bigger actors. Thus, the bigger company can enlarge and upgrade its product range, while the smaller one is able to radically improve its sales abilities and production capacities. *Buyouts, as a form of technology transfer and a method of innovation accumulation is a characteristic approach taken by multinationals towards actors on the economic periphery.* The question arises as to whether the diverse forms of technology transfer will reduce or increase differences in regard to the development of the global economy.

It can be seen that the information society, the wired society at large and the world economy stimulate innovation and make it into a means of economic survival. Creative minds may increasingly have access to the best scientific results in every area of knowledge and be able to envisage peak technological performances. Thus equipped, if they can come up with the inventions, their knowledge provides them with an opportunity from which they and indirectly their environment can benefit, even if they lack experience in business, in the legal protection of intellectual property and in financial capital. What we have here therefore is a tendency for narrowing gaps in regard to the wealth-production abilities of different countries; however, an elite group of multinationals (production and service-providing companies and financial investment companies alike) is becoming increasingly stronger.

In practice, the significance of spatial location is not reduced, since it is clearly seen that successful innovation requires bringing together more and more components: *adequate legal protection (i.e. the legal regulatory environment);, accessible venture capital;, a developed financial system and general business culture;, world standard R+D location;,*

[11] EDI (Electric Data Interchange)
MRP (Material Requirements Planning)

various forms of government support (e.g. fiscal incentives, partially underwriting venture capital investment, etc). Included with these must be the concentration of resources which are necessary for the achievement of technological break-throughs, as well as immense speed in producing "small innovations".

According to Virilio, "*Society was based on brakes all the way up to the nineteenth century, and there were hardly any tools to increase speed*" (Virilio, 1998: 42). Positions and privileges were maintained by putting into operation various brakes, such as castle walls, laws of prohibition and those securing privileges, and economic monopolies. Virilio claims that the industrial revolution was also the revolution of transportation, whether one looks at the railway, steam ships or the telegraph. When these inventions appeared it became increasingly more difficult to rein back the evolution of a global economic competition, although this was also the time when protectionist economic policy had its heyday. The flow of intellectual products, economic raw materials, half-ready and ready products grew and this process culminated in the application of infocommunication technologies. The speed of turnover reached such a level there was no way for the brakes to be put on. "*Economy is the hidden side of speed and speed is the hidden side of the economy. The two form an inseparable unit.*" (Virilio, 1998: 30). By now the expression "you are wealthy" has become synonymous with "you are fast".

It can be argued that, *given a suitable ICT background, daily co-operation is possible even at a global level.* Why can the importance of the location not be ignored then? *Various kinds of actors must find one another and trust is a key element in this.* The actors cannot judge one another's performance in a reliable way since a company manager and a scientific researcher, a development engineer, a lawyer, even a politician (who tries to interfere with the intention of introducing restrictions or giving incentives) all see the world from different angles. Mutual trust is facilitated by a shared understanding of the rules of the game (and the same legal regulation), the face-to-face handling of any disputes that arise, and visible, joint achievements. An established city in an already rich country can be regarded as a joint achievement, since *necessary competences are concentrated in big cities, as well as trust amongst the actors that have these competences.* These locations have an extremely strong appeal to capital investors, creative minds and company managers: *they become the centres of interest; things that happen there are interpreted as trends, and are adopted and adapted to by others.*

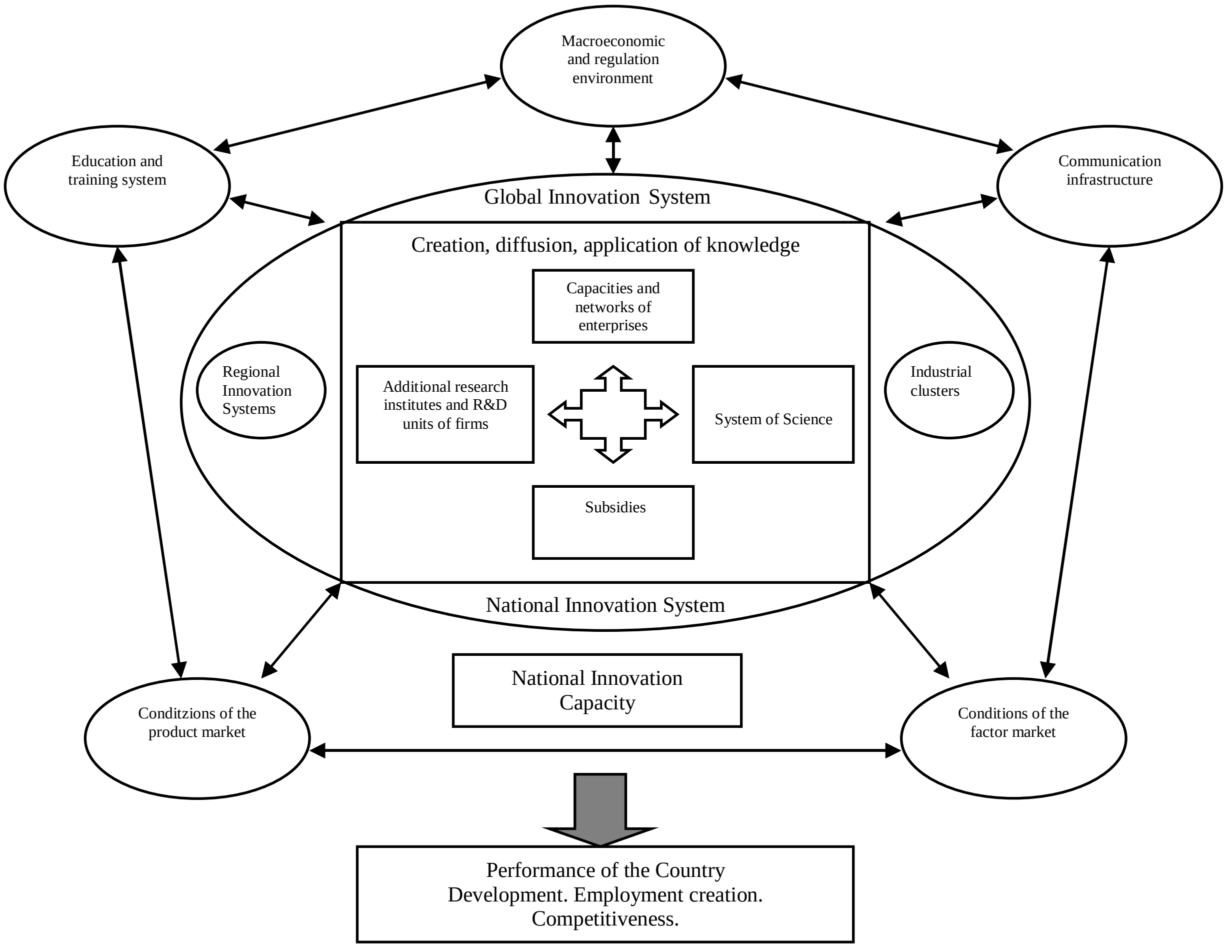
When the speed of the information flow was solely dependent on experts who mediated knowledge, there were a number of places that served as mediators between the most peripheral and the most central areas. *This "semi-periphery" seems to be disappearing now and the central position is no longer held by nations but more and more by the big cities and their hinterland* (New York, London, Tokyo, Singapore). *In countries where size imposes a limitation on the development and long-term operation of such centres, or where the location was originally on the periphery, great industrial-technological specialisation* (see Finland), *a vast concentration of resources* (see China) *must be coupled with a high degree of trust* (see Scandinavia) *or highly efficient centralised organisational performances* (see the Far East) *in order for robust and competitive networks to be formed by different types of actors.* The concentration of resources can result in less innovation-intensive economic successes (see India, the Far East). Thus, e*very part of the world (country or region) must find its own potential breakout point along the trend-line of the developing world economy and its technologies, or risk the gradual diminution of its economic significance.*

1. National and regional innovation systems

While the role of strategic planning is increasing, the opportunity for specifically state-level intervention is continuously decreasing. Academic literature on innovation uses the concepts of **National** and **Regional Innovation Systems** (NIR and RIR) to call attention to the obligations and opportunities relating to intervention in locations which are legally, economically or perhaps culturally defined. According to Freeman, the *National Innovation System* "*is the network of institutions in the state- and private sectors the activities and interactions of which initiate, import, modify and disseminate new technologies"* (OECD, 1997: 10).

"*The main objective of NIR analyses is to assess and compare the channels of knowledge flow as well as to identify bottle-necks. In this way economic policy can intervene where necessary and ensure the uninterrupted flow of knowledge. In a simplified way, we can say that it is the role of relationships between the industry, R+D and the government in scientific and technological development that is under examination"* (Borsi, 2004: 12).

3. Figure: Relations in national innovation systems



Source: OECD, 1998: 62.

It can be clearly seen in figure 3. that the innovativity of a country or region is a combination of processes involving numerous factors. It needs to be emphasised that when it comes to innovation no single factor is unrelated to any other. The system-based NIR or RIR approach is capable of dealing with numerous potential linking points that were previously described by the closed chain model of innovation processes. *This approach is especially important in that it facilitates the finding and linking of creative, non-integrated innovation centres. In this way the work done by original knowledge producers has a better chance of yielding economic benefits.*

Summary

The need for renewal is a fundamental one in the information society, since in the era of globally accessible information, real-time communication and money circulation the competitive arena has expanded. Today, even small-scale, local activities are impacted by factors and actors that used to be unknown or distant. One of the most globalised social spheres is the economy, thus it is no coincidence that the need for renewal, in the guise of 'innovation', was most intensely studied in economic science. The capacity for innovation has been specially emphasised in relation to the competitiveness of companies.

The most tangible manifestation of market success is the successful and large-scale sale of a radically new product. For this reason, innovation was primarily understood for a long time as the path leading to an entirely new product or service, or a revolutionary change in the production-manufacturing process. Nowadays it would be impossible to have such breakthroughs without a scientific foundation; therefore, the analysts of innovation first approached this theme through a linear innovation chain model. The basic premise for this model is that the new research results of scientific workshops generate technological breakthroughs because companies who are familiar with these scientific results strive to find a way to apply the newly found information and knowledge and try to convert them into a series of marketable products or services. Those who are successful in this transformation are the most competitive and most successful companies.

However, this approach has changed with time. Analysts recognised that companies basically work to find cost effective solutions to their everyday problems. In order to achieve this they may implement several tiny modifications in their organisational-logistical and production processes as well as in their product transformation and marketing activities. In themselves these may not necessarily require significant research and development work or creativity but have a very significant cumulative effect in regard to competition in market sales. In the information society, research and development, i.e. the "production" of new knowledge, can provide tangible 'raw material' that can potentially be used by thousands of actors. That is why genuinely creative research and development workshops do not necessarily have to be at the centres of economic life; they can be based in more remote and less dynamically developing countries without having to redraw the map of economic power relations.

It can be concluded from the above that in the information society, research and development, which for a long time has been regarded as the key to innovation and economic competitiveness, has an indirect impact on the competitiveness of given regions and countries. In practice, the importance of spatial location has not decreased but it has been placed in a new light. Provided that the key actors (companies, government, the scientific sphere, higher education and the non-profit sector) can trust each other enough and are willing to collaborate, success can be guaranteed by bringing together accessible venture capital, the sophisticated financial system and business culture, world standard R+D sites and various types of state support. All these factors together result in the concentration of resources required for real technological breakthroughs as well as providing the dynamism necessary for "small innovations". However, if a given facility is not available (at a reasonable price, quality or speed) in one's immediate environment, it may be possible to recruit competent partners from among the actors of more remote locations, thanks to the new level of information management. Thus, every part of the world (country or region) must find its own potential breakout point along the trend-line of the developing world economy and its technologies, or risk the gradual diminution of its economic significance. The approach in which the most important actors and processes are seen as a National Innovation System provides a solution to this situation.

Revision questions

1. Explain the principles of the chain-link and closed innovation chain models.
2. What are the similarities and differences between adaptation and innovation in a company's life?
3. When is a company forced to implement more technological development: if the scientific disciplines facilitating technological development are going through significant changes or if they are stagnating? Explain.
4. What forms of innovative enterprise were fostered by the expansion of the international capital market after World War II?
5. List at least six consequences that resulted from the use of ICT on innovation activities directly or indirectly.
6. What are the shared characteristics of successful countries and regions in regard to their network of relations (relations between companies, and relations between companies and other actors)?
7. For what reason would a company start a joint technological development with another company?

Key terms

Innovation: The implementation of a new or significantly improved product (goods or service), or process, a new marketing method, or a new organizational method in business practices, workplace organisation or external relations.

Marketing innovation: The application of new marketing methods, during which changes are introduced in product design, packaging, the launch of a product onto the market, product advertising and pricing.

National Innovation System (NIS): The network of institutions in the state- and private sectors the activities and interactions of which initiate, import, modify and disseminate new technologies. The main objective of NIS analyses is to assess and compare the channels of knowledge flow as well as to identify bottlenecks. In this way economic policy can intervene where necessary and ensure the uninterrupted flow of knowledge. In a simplified way, what is under examination is the role of relationships in scientific and technological development between industry, R+D and the government.

Organisational innovation: The implementation of new organisational methods in a company's business practices, workplace organisation or external relations.

Process innovation: The application of a new or significantly improved production or transportation method; innovation of a technological type.

Product innovation: the implementation of a new or significantly improved product or service.

Research and development (R+D): Regularly conducted creative work aimed at expanding the existing body of knowledge, including the knowledge formed about man, culture and society, as well as at using this body of knowledge in order to develop new uses. R+D incorporates three types of activities: basic research, applied research and experimental development.

Technology transfer: The process during which ideas and techniques generated in one area are applied in another area.

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