4. The process of technological catch-up

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4.1. Factors of differences in patterns of technological change

The open model of economic growth based on the Solow model assumes the conditions of full diffusion of technological advancement and capital mobility. As a result, long-term market growth rates should be the same across economies and reaching the steady state should be automatic and instantaneous. This is not the case in reality as capital and technology flows do not happen automatically, but are affected by a number of restricting factors. Therefore, the easier the flow of capital and technology, the higher the market growth rate because the inflow of capital raises savings rates, while knowledge diffusion enhances technological progress. The influence of these two factors on growth dynamics is equal since they are substitutive and complementary with each other [Barro, Sala-i-Martin, 1995, p. 281]. In the short term, knowledge diffusion works in the same way as capital inflow, while, at the same time, technological potential determines the inflow of capital investments, which guarantees the internal rate of return above the rate of return in the investing country [Brzozowski, Kubielas, 2003, p. 100].

Differences in the technological level, therefore, have a bearing on the rate of GDP. The greater the technological differences, the faster the growth. The closer the technology frontier, the more complex the technologies and the higher the cost of their transfer, which slows down diffusion. Absorption of technology depends on the absorption capabilities determined by: R&D expenditure, education, qualifications (innovation and economic policy, the quality and flexibility of the labour market), propensity for innovation, institutional infrastructure as well as the degree of economic openness. Another important factor is the ability to cover the costs of absorption and to use it efficiently for economic development.

It is possible to distinguish three main components of the process of the diversification of directions and methods of technology absorption [Rosegger, 1986, p. 211]:

- the influence of technological changes will occur in different ways on different levels, from the process of production to overall economic effects;
- the nature of these changes evolves in time;
- various new entities will successively benefit from innovation.

This approach, derived from Schumpeter's theory, treats innovation as all technological and organisational change aimed at achieving a new, better state of affairs. The most fundamental thing, from the point of view of the issue in question, is to understand the essence of technological changes involved in products and processes and their impact on the economy. A factor that determines their level is the size of R&D expenditure, i.e. capacity for innovative solutions, while the number of innovations implemented and the level of TFP (*total factor productivity*) are a reflection of their effects.

There are several categories of investment in research and development activity: basic research, applied research and experimental production. The whole cycle, from the beginning of basic research to changes in production, is called the process of innovation and varies considerably depending on the type of production [Clark, 1985, pp. 95–96]. Thus classified R&D expenditure must be clearly distinguished from non-innovative activity (e.g. routine actions).

Christopher Freeman mentions the following elements of pro-innovative research [Freeman, 1973, p. 315]:

- education;
- access to scientific and technical information;
- access to data;
- testing and standardisation of data access facilities;
- evaluation of innovation projects;
- highly specialised research staff;
- purchase of patents, licenses or know-how.

This activity should lead to the development of enterprises, branches or entire economies. R&D investment determines the growth of innovation, both of the product and process type, as the introduction of low-cost production processes is frequently accompanied by changes in the combination of manufactured goods, whereas new products often require novel technological equipment. In production activity, these two kinds of innovation are so closely intertwined that all distinctions must be arbitrary. Nevertheless, it is possible to distinguish between new ways of manufacturing traditional goods and traditional ways of producing novelties.

At the beginning of the twenty-first century, highly developed economies are undergoing profound socio-economic changes. The technology and information revolution has created new sectors based on biotechnologies, microprocessors and telecommunication, which alter the way in which production and entrepreneurship are approached. An innovation wave has caused the emergence of new kinds of supplier-customer relations, new modes of activity, quality control and production teams. Business activity has shifted from the industrial sector to the service sector. Market economies are in the midst of a cycle of, as Schumpeter phrased it, 'creative destruction.'

Technological advancement sparked off the type of transformation that accelerated along with the progressive liberalisation of the world economy. Lower costs of transport and communication, more liberal trade and elimination of financial constraints, result in a greater flow of goods, services and capital across economies, which is best reflected in the flow of direct foreign investment. All economies have become more open than only twenty years ago. Moreover, fiercer competition has boosted innovativeness. This process can be termed 'globalisation.' It encompasses hopes for faster development as well as fear of the impact of international competition on limiting the economic potential of underdeveloped countries [Berger, Dore, 1996; Friedman, 2001].

The developments in national economies and the world economy are inseparable from the influence of technological progress. It is the driving force of globalisation, and, at the same time, it is also fuelled by it [Zorska, 1998, p. 30]. Its influence on national economies can be examined from various historical perspectives. J. A. Schumpeter pointed to the long-term influence of innovation on economic growth. In his opinion, the period 1775-1845 was marked by the dominance of water power, textiles and iron, the years 1845-1900 – steam power, rail and steel, while 1900-1950 – electricity, chemicals and the internal-combustion engine. The period 1950–1990 was characterised by the development of the petrochemical industry, electronics and aviation. The current wave of innovation, started in the USA at the end of the 1980s, is driven by new solutions in the fields of digital networking, software and integrated transmission of information via the new media (and also by the impulses triggered by these changes in other areas, such as biotechnology or materials engineering) [Gordon, 2000, p. 59].

The contemporary wave of innovation has led to significant qualitative changes in the world economy [Haliżak, Kuźniar, 2000, p. 31]. Consumption of material and energy in industrial production has decreased. For the last two decades, the global production growth rate has been higher than the rate at which resources and energy are used. This means that economic growth happens under conditions of low income elasticity of demand for natural raw materials and energy resources, which leads to lower demand for these goods in the world economy and thus undermines the income of countries which specialise in exporting them.

There has been a significant improvement in the terms of trade of highly developed countries. Large and labour abundant countries, i.e. China, which possesses nearly a fifth of the world's labour force, and India, started to participate in the international division of work. The share of these countries in the world production is much lower than their share in the labour resources. They usually provide the global market with technologically unsophisticated products, although India has become one of the leading producers of software in the world.

There has been a decline in the importance of cheap labour as a source of comparative advantages. Differences in wages across countries have until recently been a factor that greatly influenced the location of businesses. This benefited countries that specialise in traditional labour-absorbing industries. In the 1980s, highly developed countries increasingly started to use automated technologies in traditional industries (the clothes and textile industry, the shoe industry, the iron and steel industry, the electronic assembly industry and the car industry). As a result, these branches are becoming technology- and capital-intensive. This helps them develop and thrive even in countries with high labour costs. Under such circumstances, advanced technologies are becoming a substitute for cheap labour offered by developing countries.

A combination of innovations in computing technology and data transmission technology (the Internet) reduces costs and shortens communication time as well as distances between people and societies, thus contributing to the development of the global information network. This creates a new quality since information is becoming a factor of production (on an equal footing with labour, capital and material natural resources) that determines a country's position in the global economy.

Thanks to technology diffusion, an equalisation of technological capabilities is taking place in enterprises located in different countries, which leads to greater technological parity. A similar tendency, labelled as technological convergence, is observable on the national level. In the process of technology diffusion a key role is played by transnational corporations, thanks to geographical integration of dispersed R&D functions/operations and the subordination of these functions to the global strategies of their mother companies.

In spite of the above phenomena, the global innovation potential is spatially strongly diversified. The countries of the world can be divided into three groups [Sachs, 2000, p.99]:

1. technological innovators, inhabited by around 15% of world's population;
2. technological adopters, about half the population (include Poland);
3. technologically excluded, the marginalised countries with no access to innovation;

Technology gaps persist between developed and developing countries, which is reflected in the coexistence of economic entities, production technologies and products representing disparate levels of technological advancement. Technology gaps are inherent in market competition. Their presence makes it possible for leading firms or countries to benefit from technological advantages. Moreover, firms are encouraged to emulate innovative excellence and take part in technology transfer. Poland, which is country with a lower level of technological development can move on a higher level by means of learning processes, which include [OECD, 1996]:

- learning-by-doing – increasing effectiveness of production by regularly repeating the same production processes;
- learning-by-using – increasing efficiency by applying more cost-effective and complex production or management systems;

- learning-by-interacting – co-operation, e.g. between the manufacturer and the purchaser in order to modernise and streamline a product;
- learning-by-learning – occurring when a firm's capacity to absorb new technologies depends on earlier learning experiences;

The last decade of research into the nature and causes of the growth of the global economy has confirmed that technological catch-up and productivity increase are not autonomous processes, but that they depend on tangible and intangible investments in education, knowledge and R&D and other related areas [Fagerberg, 1988, p. 102]. This was the basis of developing countries' success in narrowing the technology and productivity gap. This is, however not true for all developing countries, due to lack of automatism and stability in international technology diffusion [Bell, Pavitt, 1993, pp. 168–170]. Development-inducing material factors and knowledge have multiple constraints and vary as to the range of influence, and this can diminish their effectiveness. Basic knowledge is expanded by empirical experience, trials, awareness of side effects and through the processes of 'learning by doing' and 'routine learning' [Dosi, Teece, Chytry, 1998, p. 290], later diffused in enterprises in the form of training courses, new kinds of activity, experimental research and tests. Differences in technology accumulation emerge in economies and lead to technology gaps and thus to disparate levels of economic development.

4.2. Poland's technological catch-up conditions

Uneven and multidirectional technological development is typical of developing countries. However,, thanks to smoother technology diffusion, the catch-up process in many countries and of course in Poland is fluent. This is a result of better preparation of the national economic systems of these countries for taking advantage of technological globalisation. In the majority of European countries (include Poland), this as a partial process, while in Asia countries – a more comprehensive one. Technology convergence is much more efficient in those economic systems whose internal structures – including the money and capital markets, production, employment, institutions and economic openness – are well-formed. However, even efficient catch-up does not eliminate technology gaps. This opens up new possibilities for seeking competitive advantages and maintaining the continuity of technological progress [Posner, 1961; Vernon, 1966].

Differences in the manner and rate of technology flow are also associated with the type of economic system. As regards liberalism and etatism, it is possible to point out numerous factors which illustrate the diversity of technology diffusion. The most important aspects which determine the efficiency of technology adaptation are the following: the money and fiscal markets, the labour market, the technology market, the level of openness and the institutional system.

On a macro scale, technology progress is fluctuating and long-term in character, which leads to the systematic appearance of technology gaps among economies and to the differentiation and assimilation of technical capabilities and innovations [Schumpeter, 1932, pp. 135–137]. Advances or delays are dynamic because of the mechanism of technology diffusion, depending on the innovative capacity of economies, which comprises [Zielińska-Głębocka, 1996, p. 102]:

1) the science and research base of a country or firm;
2) economic stimuli impacting technological processes;
3) type of technological process (endogenous or exogenous, demand or supply);
4) character of economic policy;
5) efficiency and openness of economy.

The unevenness of technology development spurs the technological growth of particular firms at any point in time. The crux of the changes is the evolutionary character of innovation and diffusion of unequally distributed products or production technologies. The technology gaps that arise are directly connected with the diversification of technological capacities (differences are also possible across countries with similar volumes of factors of production). They are the equivalent of Smith's absolute advantages, which have a bearing on adjustment processes within economies as well as between countries. Luc Soete identifies two types of this kind of adaptation [Soete, 1990, pp. 11–12]:

1) inter-sectoral intra-national differences in technology gaps lead to specialisation in those sectors which bring comparative advantages; a static version of this concept is defined in terms of allocation efficiency (the Ricardo model), while its dynamic version, i.e. evolution of technology gaps, is Schumpeterian 'comparative advantage' (the Schumpeter model), which lead to long-term efficiency;
2) inter-sectoral international technology gaps cause changes in export shares, i.e. shifts in the structural competitiveness of economies.

What results from these processes are so-called revealed comparative advantages, which encompass changes in the allocation of resources and changes in the overall amount of outlays in international economic expansion. Technology gaps between enterprises are a vital element of market competition as they stimulate leading firms to make use of their technological advantage. They also induce backward enterprises to imitate innovation (through technology transfer) and to narrow or close the gaps.

A technological lead can be exploited by sale of technologies or direct foreign investment. It results from the decision making processes in firms concerning the volume and structure of production, R&D spending, the scale of foreign operations or the structure of investments. It also determines the intensity of goods trade stimulated by technology gaps in relation to the international capital flows and direct technology transfers between firms [Soete, 1990, p. 13].

Modern theories of foreign trade seek to define the basis of the technology trade among highly developed countries, which produce the majority of exchangeable high-tech goods. The theories take into account the following three factors [Cantner, Hanusch, 1993, pp. 217–236; Dosi, Pavitt, Soete, 1990, pp. 15–25]:

1) technological competition (different rates of technological advancement);
2) relative changes in competitive position;
3) size of technology gap.

These should be examined from the point of view of economic growth dynamics, which defines the chances of less developed, innovative imitators of achieving technological convergence. Moreover, the above factors demonstrate that innovation processes are a consequence of technological differences and that they also lead to these differences. Technological competition occurs as a result of differences in technology levels between countries, sectors or firms. Its essence is to achieve advantage over lagging economies.

Technology differences lead to the development of foreign trade for two reasons [Posner, 1961, pp. 81–83]:

1) being in possession of modern technology guarantees a monopoly and super-normal profits, which can be exploited through export activity;
2) the nature of knowledge and innovation brings about differences in the rate of growth connected with the timing of innovation or technology transfer.

Trade exchange in the world economy is virtually inseparable from competitiveness, which, in turn, is a result of higher rates of innovation. Two notions should be mentioned here: 1) competitive ability, i.e. the long-run capacity of an economy to face international competition, and 2) competitive position – the share of an economy in the international exchange [Bieńkowski, 1995, p. 32]. From the point of view of innovativeness, it is the issue of competitive ability that is of particular significance. It is connected with the size and structure of production factors and the efficiency of their use. In the factor approach, the greatest role is played by the socio-economic system and economic policy, as they are determinants of the ability to create and diffuse technological progress; of the ability to accumulate and concentrate capital; of the ability to influence the international business environment, and of the scope and manner of functioning and the degree of openness of the goods, labour and money markets.

The components of the socio-economic system that merit particular attention are those that decide about such features of an economy such as: the capacity to develop and diffuse new technologies, technology transfer, accumulation and concentration of capital as well as the ability to influence the international business environment. This kind of impact of technology progress on economic growth and competitive conditions indicates the growing importance of micro-economic factors, which have an influence on elasticity and innovativeness and also on adaptive capacity under changing competitive circumstances. It follows from the above that countries which offer conditions conducive to technology growth, thanks to high R&D expenditure, establishment of legal infrastructure and appropriate state policy, at the same time favour the creation of competitive micro- and macro-economic structures [Bieńkowski, 1995, p. 33]. Thus a technological lead can be exploited by sale of technologies or direct foreign investment. This is a result of the decision making processes in firms concerning the quantity and structure of production, R&D spending, the scale of foreign operations or the structure of investments. It also determines the intensity of goods trade stimulated by technology gaps in relation to the international capital flows and direct technology transfers between firms [Soete, 1990, p. 13].

Highly developed countries used to concentrate on their territories practically the entire innovative activity, although they differed considerably from one another as to the level of technical development. However, since mid-1980s, it has been possible to observe major changes in this respect. These changes are: technological convergence, shortening of the imitation lag of underdeveloped countries, change of technological leadership (decreased dominance of the USA, strengthened position of Japan and Western Europe and less developed countries), growing potential of Asia, as well as the impact of innovation rates on shares in the export market and competitiveness [Posner, 1961, p. 85].

Changes in the world map of innovation are a result of narrowing the technology gaps and growth of international competition, which, in turn, is shaped by:

a) the phenomenon of learning, which promotes the dynamization of comparative and competitive advantages; it encompasses two elements: one is Arrow's *learning by doing*, connected with the cumulative process of goods manufacture, with the lengthening of production series (economy of scale) and involving R&D expenditure; the other one is employing skilled labour with a view to learning new production processes (*learning to learn*) [Posner, 1961, p. 86];
b) imitation lag, which reflects the nature of technological change and means that imitators start to apply new technologies only after some time elapses; it stems from the learning period and from the domestic and foreign reaction lag [Posner, 1961, p. 87];
c) the life cycle of products; related innovations are only those of the product type; product life cycle causes the erosion of dynamic comparative advantages, while the factor that determines the pace of the erosion is the rate at which products mature and not the time necessary to learn and respond to the technological developments in other countries or enterprises; at the early stages of the cycle it is the innovating countries that reap the greatest benefits by becoming exporters of the novel prod-

ucts; the export is directed at countries which do not manufacture this particular version of the product, i.e. the import is non-competitive; this type of goods are usually sold to countries with high income and high demand [Vernon, 1966, vol. 130].

The above factors demonstrate that innovation should be analysed in the light of globalisation of innovation processes and their evolving significance for both developed and developing economies.

4.3. Directions and range of technological catch-up in open-economy

To sum up, there are two phases of the process of trade exchange of the 1980s and 1990s which make the two periods in question similar. The first one was greater participation of transnational firms in the foreign trade, which was of tremendous importance for capital flows as there was exchange among economies which were, at the same time, importers and exporters for one another, thus contributing to further liberalisation of the market.

The second phase was the possibility of absorption of unbalanced trade. The most significant seems to be the fast growth of both direct and portfolio foreign investments. After the reduction of direct investments in the 1970s, the next two decades appear to be have brought an extraordinary expansion of those (the rate of growth was four times that of the GDP). Their direction changed as well. A large part of British foreign investment went directly to the USA and other highly developed countries, and not, like before, mainly to developing countries, which offered raw materials, cheap labour, accessible know-how, a guarantee of currency stability or tax reliefs. At the end of the 1980s, rapid technological progress lessened the attractiveness of low labour cost economies and shifted investment towards highly developed countries with better technological potential.

Success in rivalry on a global scale depends on the ability to achieve competitive advantages in business environment and on the accessibility of resources necessary to generate new products and processes. The product life cycle has been definitely shortened, which strengthened the importance of innovation and entrepreneurship. Enterprises maintain competitive advantages by acting more intelligently than their competitors, and this is made possible by generating new products and applying new ideas in the existing technological processes.

International connections and innovation mechanisms allow the acquisition of new knowledge and transform it into higher productivity and higher income. The efficiency of innovation is measured by the innovation potential of an economy understood not only as the commercialisation of R&D results, but also as the degree of openness to foreign ideas, broadened synergy and interaction among forms or between firms and the science base as well as the fostering of entrepreneurship. Thus the following set of indicators of innovation efficiency can be distinguished [CSO, 2003, s. 38]:

- technology commercialisation – every kind of knowledge used in enterprises should be commercialised;
- openness to foreign ideas – interest in and ability to obtain global resources of knowledge;
- transfer of knowledge and technology – enterprises which compete on a global scale must acquire knowledge and qualifications through new forms of international co-operation;
- entrepreneurship – ability to gain new development opportunities and their efficient implementation.

The success of innovative products and processes requires, therefore, not only expenditure on R&D, but also on training, marketing, material endowment and design. Although general data on R&D expenditure do not show its efficiency, but they do define the link with the innovation process.

Many European enterprises, both from the industrial and service sectors, notice the significance of innovation and develop product and process activities. The amount of innovation investment of industrial firms is a debatable issue, however, the number of innovative enterprises is too small and the ratio between innovation expenditure and income is too low. Achieving a high level of growth in the long term requires increased expenditure and a greater propensity to take risks.

Assessment of potential innovation success should take into account implementation effects, i.e. the volume of income from the sales of new products or cost savings achieved thanks to new technologies. Taking this type of data into consideration allows to assess the level of entrepreneurship and to determine how innovation success reflects market behaviour.

Analysis of data concerning technological competitiveness confirms the earlier observations that an innovation gap divides Europe from the USA and the most developed Asian countries. The existence of technology and investment gaps can be partly explained by differences in R&D spending, the scope of innovation policy and the opportunities to build a 'learning economy.' On the other hand, there are a number of positive aspects of innovation activity and increased technological competitiveness of European economies. They include:

- macroeconomic situation, political and legal stability;
- openness and competitiveness of the economy whose regulation is relatively limited and whose political and economic institutions are very well perceived by foreign investors;

- well-developed and gradually strengthened science base, which facilitates the absorption of new ideas and foreign knowledge provided through international investment and R&D co-operation;
- well-developed ICT (*information and communication technologies*) sector;
- dynamically developing knowledge-based sectors: software, pharmaceuticals, biotechnologies and finances; their growing share in export.

It seems that it is the Poland's ICT sector that should play a particularly important role in accelerating the speed with which the innovation gap is closed. Its potential is high at the moment and can be the driving force behind innovation growth. This is even more probable because the clear and rather unexpected increase in labour efficiency (GDP per hour worked) has been, to a large extent, brought about by the dynamic growth of this sector.

Increased ICT investment results from a considerable drop in the prices of computer and computer accessories, from rapid technological progress in the production of semi-conductors, and also from greater volume of technology transfer in the world economy. It is significant in so far as the ICT sector plays a double role in the modern economy:

1) it is a productive effect of high-tech industries;
2) its output is a factor of production which has high efficiency for other sectors and branches of economy.

The current information revolution is characterised by rapidly increasing quality of ICT equipment and software accompanied by a diminished tendency to raise prices. The maximisation of consumer utility and the maximisation of producer's profits are reflected in the changes of relative prices resulting from substitutive processes in particular fields. The sudden surge of technological advantages was, therefore, possible thanks to the greater share of ICT in GDP and in capital resources, along with the simultaneous significant decrease in prices.

In order to identify the channels of ICT impact on production, productivity and economic growth (closing the technology gap), the aggregate neoclassical production function should be used [Pohjola, 2002, pp. 385–394]:

$$Y_t = Y\left(Y_t^{ICT}, Y_t^{O}\right) = A_t F\left(C_t, K_t, H_t, L_t\right), \tag{1}$$

where:

Y – aggregate added value of ICT production (Y^{ICT}) and other kinds of activity (Y^{O}),
C – ICT capital, K – other kinds of capital, H – human capital, L – labour, A – Hicks-neutral technological progress.

Thus, ICT can be perceived as an effect of production and economic growth for three reasons [Pohjola, 2002]:

1) production of goods and services creates a part of the total added value of an economy;

2) deployment of ICT capital (C_t) for production of all goods and services turned out by an economy accelerates economic growth;
3) ICT enhances economic growth through participation in technological progress. If the fast increase in ICT production is based on efficiency growth, a rise in the total macroeconomic productivity will occur.

As was mentioned earlier, there are two ways in which the ICT sector can accelerate economic growth: direct participation of ICT goods in generating GDP and the share of ICT branches in technological progress. Having differentiated the left-hand side of the equation by time, we obtain:

$$\hat{Y} = w_{ICT} \cdot \hat{Y}^{ICT} + w_O \cdot \hat{Y}^O , \qquad (2)$$

where:

$\hat{Y}$ is the weighted rate of change, and w the share of ICT and other kinds of activity in the total product.

ICT is a basic source of technological progress, and thus has the greatest influence on the rise in the TFP indicator. Using Dale Jorgenson's methodology, it can be observed that the TFP growth in the USA in 1990s resulted from the increased share of ICT. According to Dirk Pilat and Frank Lee, in Finland (in the same period) this share and the TFP rose [Pilat, Lee, 2001, p. 24].

Unlike in the USA, in Europe (include Poland) the second half of the 1990s brought increased volume of trade in high-tech goods and the drop of prices for IT products had a positive impact on the entire world economy by influencing the TFP and through structural changes.

The *catch-up* process in Poland is much faster than it seemed only a few years ago. The closing of the technological distance between slow-adopters and the European countries has been clearly noticeable since the beginning of the 1990s. Most important, the tendency to invest in ICT and the process of closing the technology gap are distinctly accelerating.

ICT diffusion is one of the two basic determinants of growth in modern economies. According to R. Solow, investing in the information technology sector will lead to greater productivity, provided that it is accompanied by organisational changes concerning better exploitation of ICT by enterprises [Solow, 1957, pp. 312–320].

In spite of the catch-up in the ICT branch, in the majority of European countries (include Poland) TFP has not risen very much. This indicates the so-called 'Solow paradox', that is the lack of correlation between the level of ICT investment and the growth of organisational capabilities. Initially, ICT expenditure accelerates efficiency growth, which simply results from the impact that such investment has on the demand dynamics of market and income growth. In the long term, however, further changes in firms' activities are indispensable as without them productivity cannot increase.

To sum up, the most important issues related to the influence of innovation on the process of catch-up in Poland are as follows:

- intensity of innovation – low level of innovation is part of the syndrome whose other components are the resultant lower productivity and weaker international competitiveness;
- lack of innovation in strategic development priorities – this hampers the ambition and the motivation of firms to strengthen their technological competences and to develop new types of activities;
- limited internal sources of innovation – investments in R&D and in the promotion of technological capabilities are insufficient;
- organisation and management – many enterprises do not make use of the opportunity to adopt new modes of functioning;
- rapid growth and greater innovativeness of the SME sector;
- emergence of knowledge and experience gap. This is particularly noticeable among firms operating on global markets with their ever-expanding resources of knowledge, technology, globalisation and the emerging e-commerce business. Absence of radical organisational changes aimed at adjusting to the developments in the world economy can marginalise some firms;
- sudden increase of science and technology resources – growing scope for enterprises to adopt new production, organisational or financing techniques;
- better exploitation of the strengths of the science base;
- wider application of ICT infrastructure;
- better alignment between suppliers and recipients of technology;
- better use of technological infrastructure in enterprises
- pursuing sustainable development goals.

The last twenty years have been, therefore, a revolution in the perception of the role and significance of innovation both in the social and economic spheres. Unfortunately, innovation policy does not always keep pace with these changes. Nevertheless, a substantial number of policy initiatives are a response to the challenge of the global economy.

The innovation status of many countries compared to the USA is far better today than twenty years ago, even though a technology gap still exists. The implementation aspects of innovation have undoubtedly improved: production of and access to ICT goods have been increased, new technological processes have appeared in enterprises, the efficiency of firms has risen. As regards innovation, the situation is worse due to lower R&D expenditure and the limited role of the state in technological progress.

Interestingly, enterprises clearly tend towards a global approach, in which foreign subsidiaries of firms are subsidised and specialist business networks are created. New organisational structures come into being, which can assume the following forms [Bartlett, Ghoshal, 1991, p. 49]:

- multinational organisation;
- international organisation;
- global organisation.

Enterprises swiftly go through the above phases and aspire to become transnational organisations. The greatest advantage of the transnational approach is dispersed potential and assets, independence and high specialisation, making it possible to recognise market needs, innovation tendencies and the strength of the competition. This is extremely important from the point of view of stimulating sources of innovation and from the point of view of cost-differentiation, since it allows reduction of capital intensity and labour intensity and increase in the sources of technological and organisational advancement.

The overall costs of innovation in a country like India, where the qualifications of research staff are comparable to those in Western Europe, constitute about a tenth of the labour costs in the European Union. This indicates the important role of the 'rising economies' in off-shore production and the possibility to seek innovation in less developed markets.

Apart from high costs of access to innovation in highly developed countries, another difficulty is the lack of high-skilled labour. This applies to Western Europe, the USA and Japan to the same extent. Many developing countries possess much larger stocks of well-educated human capital.

The evaluation of the model of research co-operation between countries and enterprises attests to the tremendous significance of international markets for investment in R&D, knowledge, education or engineering personnel. The modern market mechanism, the process of globalisation and the necessity to raise competitiveness lead to an increase in direct investment in those regions which offer both substantial research resources and suitably qualified staff. That is why transnational enterprises choose such countries as Israel, Brazil, India (ranked third in the world for the number of scientists), South Korea (educates as many engineers every year as Germany or Sweden), Singapore or the countries of the Far East. As American studies show, more than 97% of enterprises try to gain access to innovation outside the Triad countries. It shows there are create new centres of innovation development, which are results of technological diffusion [Chatterji, Manuel, 1999, pp. 21–26].

Globalisation of innovative activities is, therefore, a continuous and inevitable process, in which a pivotal role is played by the links among the home countries, the host countries and the transnational enterprises. They determine changes in science and research systems and impact the location of high-tech production.

The growing innovativeness of economies should be analysed in view of the increasingly dynamic catch-up process. Thus, it is closely connected with the rates of R&D expenditure, the efficiency of the education system and the development of institutional infrastructure which supports technology transfer. Negligence in intra-sectoral specialisation adjustments (based on the technology and innovation factors) and staying within the confines of the traditional inter-sectoral exchange (based on comparative advantages) may slow down the narrowing of the development divide between some economies and their main competitors.

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