5. Technological competitiveness of the national economy

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5.1. Introduction

The last few decades have witnessed changes in production and technology structure which have led to a shift in the significance of particular sectors. Economies have clearly entered the post-industrial phase, which means an increased importance of the service sector and a diminished role of industry. Additionally, this transition is accompanied by changes in the innovation processes of companies. The growing dominance of high-technology branches has enhanced technological competitiveness. The changes of structure have not influenced the overall level of innovation, but have boosted those sectors whose R&D expenditure is high and which implement new technical and technological solutions in the most efficient way.

5.2. Global conditions for technology development

Under conditions of market globalisation, gaining competitive advantages heavily depends on innovation capability and technology transfer efficiency. International technology capabilities are, therefore, essential for economic growth in open economies. From the point of view of enterprises, going beyond national boundaries in order to streamline technological solutions is indispensable. On the contrary, it is quite frequently connected with potential threats. This is a crucial argument in the discussion which concerns not globalization itself, but the possibilities of concentration or dispersion of activities that raise the level of innovation [Freeman, Hagedoorn, 1995, p. 53].

The global economy is characterised by [Dunning, 2001, p. 12]:

- international transactions concerning an increasing number of goods and services (visible and invisible) and close ties among economic entities across the globe;

- mobility of resources, raw materials, goods, services and economic potential;
- increased significance of transnational enterprises;
- lower ability to predict real and financial activity in global markets (especially the capital and foreign exchange markets);
- increased role of *e–commerce* and a definite change in the character and location of international exchange (mainly in services).

Nowadays, the essence of development is to take advantage of intellectual capital and knowledge embodied in both material and human capital as well as in tangible and intangible assets. Moreover, a spatial concentration of economic activity of various kinds is very clearly noticeable (the 'sticky places' paradox), as are considerable economic openness, greater enterprise co-operation (among firms and within them, between firms and institutions) and a growing number of strategic alliances.

Having considered the wide reach of globalisation and the objectives to be achieved, Dunning presents three possible scenarios of its further development [Dunning, 1999, pp. 67–69]:

1) 'creative destruction' of global capitalism – some economists (A. Marshall, J. Schumpeter) claimed long ago that the capitalist economy has a capacity for self-purification and for reinforcing its mechanisms through pursuing sustainable growth;
2) the *muddling through* or *Band-Aid* solution – marginal adjustments to the status-quo of existing markets, extra-market institutions (including governments), social mores or behavioural patterns;
3) recognition and analysis of the development of the global economy, which will allow minimization of costs and increase the benefits of technological globalisation.

Analysis of the development processes in modern economies shows that (3) would be the most advantageous solution. In reality, however, (2) is beginning to prevail. Therefore, there is a need for a systemic approach to global markets and for energetic international activity within the framework of the institutional system which determines greater adaptive efficiency.

As regards the creation and character of technological progress, what merits attention is the considerable intensification of international knowledge flows, mainly towards the end of the twentieth century. It was caused by the rapid advancement in information flow technologies: telephony, television, the Internet and the emergence of an information based economy with its focus on international innovation and extensive use of technology transfer channels. What is more, the necessity to dynamize economic growth raised the demand for human capital and thus provided an impulse to streamline education systems. It should be emphasized that human capital and education have become global factors and access to them is practically unlimited today.

The flow of information and human capital has increased development opportunities for both enterprises and economies. Firms have become transnational, while economies have opened up. Recent years have brought an increase in the extent and volume of entrepreneurial activity through the improvement of international information flows and their application for market expansion as well as the virtual elimination of national borders. Transnational enterprises produce their goods and services all over the world and in this way they become global.

Transnational enterprises become independent entities whose activity has a worldwide reach. This is also true for the resultant innovation processes, which are determined by [Freeman, Hagedoorn, 1995, p.56]:

- differences in remuneration of production factors – firms locate their activities where costs are lower;
- necessity for firms to have direct control of critical assets, which guarantees stability of innovation;
- transaction costs of obtaining technological potential;
- uneven distribution of competitive advantages (technology gaps).

In view of the above, it can be said that the size of R&D expenditure (*knowledge-based economy*) and efficient technology transfer (*learning economy*) are the keystones of contemporary innovation.

R&D activity fosters the development of numerous branches and firms. However, it is not a universal means of strengthening economic potential. Sometimes excessive significance is attributed to education and the accumulation of capital, while the impact of the particular components of technological progress is overlooked [Mankiw, 1995, p. 290]. In the long term, it is technology transfer that is of greatest consequence to innovation development because it leads to productivity growth and enables less developed countries to close the economic gap (catch-up process). Therefore, the rate of return from investments in innovation is more than twice as high as that from investments in material capital. What is more, it grows in those branches where R&D expenditure is on the rise. What also matters, the growth of R&D and better technology transfer spread to other countries participating in the international division of labour and raise their competitiveness.

Technological progress is becoming, therefore, a global phenomenon as far as its creation and diffusion are concerned. Its smooth implementation is then synonymous with the efficiency of international technology transfer. Enterprises will locate their activity in economies which guarantee high efficiency and profitability of ventures. That is why particular countries must be systemically prepared for international investments in order to guarantee a positive influence of those investments on development dynamics. Otherwise the effects of the activity of international corporations may turn out to be adverse.

5.3. Technological expansion capabilities

The elementary model of technological expansion of transnational corporations is based on two primary assumptions relating to the impact of technology transfer on competitiveness [Flaherty, 1986, pp. 92–94]:

1) technical intensity creates competitive advantages which are easily transferrable within a firm, but not so easily outside it;
2) enterprises, using their own foreign production technology, can obtain higher rates of return from (technological) investments, which is possible thanks to the sale of technologies and supernormal profits.

Technology can be transferred in the form of tangible assets: new products, machines, capital equipment, or in the form of intangible assets: patents, licenses or knowledge. It is worth noting that there is an important distinction between the flow of knowledge and the flow of information. Information is a certain individual quantity or a stream of data, whereas knowledge means utilisation of information in a broader sense. Knowledge combines the processes of learning and cognition under the conditions of its transfer (diffusion) from the individual to the institutional level.

From the point of view of technology transfer, there are two kinds of knowledge: un-codified (tacit) knowledge and implementation (applied) knowledge. Implementation knowledge comprises know-how, which can be formally transferred (by means of instructions or projects), while codified knowledge is passed on through direct experience. The differences in the nature and type of technology and knowledge are particularly important for their creation in the form of tangible investments and their transfer channels. Such differentiation between technology transfer and codified knowledge is dependent on geographical distance, whereas in the case of implementation knowledge it only depends on the level of efficiency that can be achieved [Antonelli, 1995, p. 47].

The traditional model shows the mechanism of technology transfer from domestic enterprises to their foreign subsidiaries. It is the mother companies that derive the most benefits from further application of new technologies in products and processes. The pivotal part of this phenomenon is the form of technology embodiment (licenses, instructions, know-how), which later translates into the results of the entire innovation process. The mechanism of technology supply allows a better understanding and more effective learning of the innovation process, which, in turn, helps to provide long-term favourable conditions for firms which create innovations and those enterprises that purchase them. It should be noted that a new technology is new to the enterprise as a whole. Moreover, firms must be prepared, in terms of organization and employee qualifications, for assimilation and adaptation of novel solutions. If this condition is not fulfilled, it can happen that mature technologies will be more easily adaptable than new ones.

Thus in those firms which are prepared for technology transfer, accumulation of experimental knowledge is simpler than the adaptation of new technologies.

The pace of technological progress and technology transfer will accelerate when transnational enterprises increase the flow of 'soft' technologies, which will result in the growth of competitive advantages in the area of disembodied technologies. The absorption capacities of foreign subsidiaries should be increased in order to facilitate the development of the acquired technologies. The organisational strategies of firms must depart from the transfer of existing technologies and turn towards knowledge transfer and raising qualifications so as to reinforce research potential and enhance growth.

In the process of globalisation, enterprises tend towards strategies which allow greater openness and, as William Lazonick and Michael Porter claim, a change of attitude to technological progress through the creation of 'enterprise clusters' based on specialisation and innovation in various parts of the world economy [Lazonick, 1993, pp. 18–19; Porter, 1990, pp. 168–171]. Robert B. Reich claims that the point of global technological networks is to set up enterprises where technological solutions from different countries can be integrated [Reich, 1991, pp. 148–152]. Thomas Allen and Oscar Hauptman distinguish within technological globalisation the emergence of 'functional organisations', whose purpose is to unite individual participants in clusters that work on a variety of problems and the formation of 'project organisations', which seek employees who would carry out specified tasks [Allen, Hauptman, 1987, pp. 575–587]. In the subsequent stage, synergy of these two structures occurs, 'structural space' is formed which creates new generations of technologies and determines the degree of advancement and the extent of coordination of all the elements. Co-operation for exploitation of knowledge and technology on a global scale provides a chance for optimising the functions of enterprises in terms of technology transfer, production and R&D activity. Enterprises which manage to achieve global status direct their activities towards economies with high, or rapidly growing, research and technology potential.

Global enterprise networks can be divided into horizontal and vertical ones. Horizontal relationships are very limited and concern only basic functional links (e.g. production). On the other hand,, vertical relationships encompass particular elements of the world economy as well as the development of new product cycles (the Schumpeterian triad) along with competitive advantage possibilities.

Practice shows that horizontal relationships concern embodied techniques and codified knowledge included in the applied technologies and connecting particular components of transnational companies. The strength of these dependencies is determined by the character of product and process innovations conducted by enterprises. It has a bearing on the possibilities of cost reduction and offering access to the techniques to a larger number of partners. Growth in terms of horizontal relationships can be, therefore, perceived as increased access to raw materials and the introduction of standardisation of products and technical processes

[Levy, Dunning, 1993, pp. 22–26]. In the longer term, this can lead to the creation of a stable source of raw materials and a network of co-operating firms.

Vertical relationships reflect the connections between R&D expenditure, production, marketing and sales, which constitute a certain functional sequence. Traditionally, it can be observed within national economies, but some of their elements are moved beyond national borders to subsidiaries of domestic enterprises [Howells, 1998, p. 59]. An example of this is GlaxoSmithKline, which outsources parts of its innovation process from Great Britain to Singapore or France, where it is completed and then directed back to the market of origin.

Factors which impact the internationalisation of technology transfer are changeable in time. Statistical data suggest a clear rise in the importance of supply factors, which will result in lower accessibility of high-skilled workers in the research and development sector as well as shortages of technical staff [Cantwell, 1995, pp. 162–164]. This is tantamount to a decrease in the significance of demand factors, which, in turn, stems directly from the 'globalisation of product flows'. This process also diminished possibility to adopt technologically new products within local markets, because there is very low demand depend on low income. It is worth noting that innovation activity of large corporations does not take place in very many countries and is limited to, first and foremost, the USA, Japan and Europe.

A significant increase of foreign R&D activity of transnational companies has recently become integral part of changes in their global competition strategies. According to Robert D. Pearce, the new strategic approach revises the role of subsidiaries and their interrelationships [Pearce, 1999, pp. 159–162]. Traditionally, the scope of R&D carried out by foreign subsidiaries had to fall within the framework of mutual relationships between the mother company and its affiliates. The modern approach involves various actions occurring within an independent network of mutual support. Nowadays, entities which create foreign R&D provide a considerable part of the resources indispensable for technological progress and, what is important, their role is growing.

The international division of technological capacities of economies based on transnational corporations is the basis for partnership and technological synergy and technology transfer. For enterprises, internationalisation of technological activity is a necessity. However, it is not unequivocally beneficial. On the contrary, it frequently means potential threats. This is an important argument in the discussion of not so much globalisation itself as the possibilities of concentration or dispersion of activities aimed at boosting innovation.

Analysis shows that the internationalisation of R&D is imperative. What is of great importance to companies is not the change in the nature of this process but the possibility to broaden its range. International enterprises create the foundations of technological progress on the global scale, greatly expanding the development capabilities of economies and also increasing their competitiveness thanks to the evolution of the high-tech goods market.

Ever since international firms started to locate their branches and subsidiaries abroad with a view to adapt new products or technological processes, the process of reverse technology transfer has been taking place.

The main reason for which foreign laboratories transfer such a large number of technologies back to mother companies is the lack of possibility of long-term servicing and adaptation. Firms which are the recipients of new technologies expect to be able to promptly implement the novel solutions in new products and processes. If this is not possible, the transfer direction is reversed. Reverse technology transfer is, therefore, very significant for the profitability and way of functioning of the dominant enterprises [Ciborowski, 2000, p. 47].

5.4. Globalisation tendencies and their influence on competitiveness

These days, competitive strategies of enterprises increasingly focus on international rivalry. It is vastly different from internal competition. A particularly important role is played here by governmental institutions, whose activity is supposed to stimulate the creation of competitive mechanisms and improve the competitive ability. This is why competitive ability should incorporate a number of development factors such as [Bieńkowski, 1995, p. 32]: the volume and structure of production factors, the efficiency of their utilisation, the socio-economic system, state economic policy, the international background.

What is of great significance are the components of the socio-economic system which determine such features of an economy as: the ability to create and diffuse advanced technologies, technology transfer, accumulation of capital and the impact on the international environment.

A key role in competitiveness of economies is played by the technological factor, which has a huge influence on the character and pace of growth in highly developed countries via changes in the structure of industrial branches as well as through their modernisation. Moreover, the technological factor necessitates changes in the structure of industry by enforcing greater concentration of high-risk outlays and enables research and production in new organisational configurations so that activities can be transferred to small and medium companies and new competitive structures can arise.

This kind of impact of technology on economic growth and on internal and external competition indicates greater significance of macroeconomic factors, which influence elasticity and innovativeness as well as on adaptive capacities in changing competitive conditions. It follows that those countries which build conditions conducive to the creation and adaptation of new technologies thanks to high R&D expenditure, solid legal infrastructure and an appropriate state policy at the same time foster micro- and macro-economic competitive structures.

There are substantial differences as to the globalisation level of enterprises across branches and sectors. In Great Britain, the pharmaceutical branch, the food industry or the machinery and transport industry are highly internationalised [Niosi, 1999, pp. 107–117]. As regards Japan, firms which conduct most of their R&D activity abroad produce electronic equipment, pharmaceuticals and cars. In general, it can be noticed that the technological intensity of some branches, e.g. the electronic, biotechnological or pharmaceutical industries, tend towards internationalisation much more than any others [Prasada, 2000, p. 2]. In Poland, there is a few high-tech branches, so technology transfer should be analysis through capabilities of apply mid- or low-technology solutions in machinery, manufacturing or metal production. Poland's branches are low technological intensity but could use technological solutions from the world's enterprises.

The last few decades have brought a number of methods of exploiting global innovation opportunities. The most interesting seems to be the one presented by Bartlett and Ghoshal, which puts forward four types of innovation management [Bartlett, Ghoshal, 1991, pp. 29–34]:

1) *centre-for-global* – development, in the home country, of new products and processes for global markets;
2) *local-for-local* – independent development of products and processes in every foreign R&D unit for local use;
3) *locally linked* – development of innovatory products and processes in every global location;
4) *globally linked* – development of innovation synergy of units located in different countries and contributing to global markets.

Each of the above has its advantages and drawbacks, but all four can be used simultaneously for various purposes within the same transnational enterprises.

Hakason claims that the R&D organisational structure of transnational corporations has undergone three stages of evolution [Hakason, 1990, p. 261]:

1) centralisation of activity;
2) decentralisation of particular segments of activity;
3) network alignment;

In the 1970s, an explanation of direct investment growth was provided by the product life cycle model. Transnational firms were viewed as those which develop new technologies in the home country and later transfer them to their foreign subsidiaries, where they matured. R&D expenditure became a category that brought together various functions of an enterprise and enhanced research activity in the home country. The model assumed the centralisation of R&D spending through the establishment of one or more laboratories in the home country and several mini laboratories abroad in order to adjust patent technologies to local conditions. However, numerous further studies showed that the product life cycle model did not accurately reflect the processes of internationalisation and globalisation. Transnational corporations diffused technology much faster than the model suggested. Moreover, clear differences in the way they approached innova-

tion could be observed across countries. There were also sectoral differences which proved that firms in highly developed countries have a greater tendency towards globalisation of R&D than those in less developed and underdeveloped countries [Niosi, 1999, p. 111].

The increased globalisation of technological alliances is another important aspect of technological globalisation. The traditional perspective based on transactional costs sees transnational corporations as entities which develop technologies in the home country and diffuse them via technology transfer to their own subsidiaries rather than sell them to other firms. Since the late 1980s, transnational corporations have been forming technological alliances with other firms and research institutions with a view to develop new products and processes. This strategy is the opposite of the earlier strategy of internationalisation. According to the evolutional approach, such alliances are a strategy for achieving a better competitive position in an uncertain business environment.

For Pearce, the increased importance of foreign innovation in transnational corporation reflects [Pearce, 1999, p. 157]:

- growing involvement of firms in product development, and not just product adaptation;
- independent position in technology group schemes;
- growing significance of the supply side of technology;
- decline of R&D centralisation (e.g. economy of scale, communication and coordination of problems, security of knowledge).

The scope and the level of technological performance of transnational enterprises are determined by the economic potential of both the home and host countries. If an enterprise originates from a technologically well developed country and transfers its activity to a country with a lower level of technology, differentiation of innovation activity and specialisation occurs, in accordance with local technical capacity.

Innovatory activity, manufacturing of developed products for global markets as well as knowledge- and research-based strategies of transnational firms create conditions for boosting the innovation potential and economic growth of recipient countries.

As a result of changes in the global competition model connected with the rapid technological progress, product life cycle is shortened and innovation is treated as a key factor of competitive advantage. Enterprises deploy various strategies in order to attain higher technological standards and improve competitiveness. Consequently, they broaden the expansion of not only their marketing and production activity but also of their research and development performance. Several reasons for the internationalisation of innovation in terms of R&D can be indicated [Terpstra, 1999, pp. 26–27]:

- transfer of technology from headquarters to foreign subsidiaries;
- technological advancement of host countries;
- location incentives for countries which pursue technological activities;

- acquisition of foreign research and scientific staff;
- reduction of technological development costs;
- exploitation of local advantages;
- parallel co-operation of different types of laboratories;
- improvement of R&D efficiency;
- more favourable tax law.

The socio-economic and technological development of the last few decades has led to the unification of markets whose customers demand increasing quantities of goods. These requirements allow global economies to remain competitive. At the same time, particular segments of the market require product differentiation so as to highlight their unique qualities.

The convergence of consumer preferences in the world economy and the international diffusion of technological progress have had an impact on the location of innovative activity. Enterprises can no longer base their innovation strategies solely on internal circumstances as those do not guarantee full development opportunities. Nowadays, new needs and trends force firms to expand their market potential through seeking foreign locations. Firms endeavour to gain competitive advantage by defining their needs in one country, establishing the conditions of their fulfilment and locating activity in another and then transferring the results to global markets [Bartlett, Ghoshal, 1991, p. 12].

The technological dimension of global competition draws attention to the location of technological progress functions. The literature on the subject suggests that innovative activity is usually located in close proximity to large, existing or potential, markets and developed industrial or service areas. Thus, trans-national corporations conduct technological innovation in countries where they enjoy comparative advantages and it does not have to necessarily be only one country (Western Europe, the USA).

Innovation activity broadens the scope of used knowledge. More and more disciplines seem to be instrumental in the creation and development of technology, which causes a rise in the number of innovation sources both in the geographical (new countries) and functional sense (more extensive co-operation with research units and other firms). One of the consequences of the dynamic innovation development of the business environment of firms is stronger competitive pressure and growing expectations as to the sphere of science and research.

According to John Cantwell, international enterprises change their attitude towards technological progress for two reasons [Cantwell, 1999, pp. 81–83]:

1) in order to gain technological advantage within international innovation systems and to obtain access to complementary solutions;
2) to gain access to new sources of innovations.

The blurring of the borders between very different research fields prompts firms to expand their technological bases through changes in international strategies and the creation of new competitive conditions.

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