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Technical innovations versus the process of creating knowledge-based economy

Abstract

The article presents fundamental issues concerning understanding and interpretation of the idea of sustainable development in the context of ongoing processes of globalization.

For many years sustainable development has been perceived by scientists, politicians and entrepreneurs as the idea that is attractive in conceptual terms. However, as regards realization of the postulate of sustainable development, many barriers are encountered owing to the fact that its successful implementation is conditioned by a firm and well coordinated economic policy on a global scale, or at least on the scale of its particular regions. Simultaneously, contemporary global economy is dominated by the processes of globalization that are characterized by their spontaneity, unpredictability and absolute subordination to the functioning of market mechanism. Consistencies ensuing from it hamper realization of the idea of sustainable development, the value of which is frequently questioned. Thus, what is appreciated presently is aspiration to find appropriate methods of overcoming barriers that hamper sustainable development. This aspiration regards many scientific, political and business spheres.

Multidimensionality of the category of innovation enables analysis of innovations in various aspects of economic changes. It is most frequently linked with the theory of economic growth and associated with the possibilities of accelerating it. Simultaneously, innovation implies certain changes in terms of quality that determine long-term social tendencies. Thus, innovation processes may be linked with the paradigm of knowledge-based economy or the so-called "*learning economy*".

The aim of this article is to present various aspects of innovation changes leading to creation of knowledge economy or realization of the assumptions of "*learning economy*".

1. THE ESSENCE OF INNOVATION CHANGES

In classical perspective, innovations are either related to economical use of production factors, their proper allocation, character of production process, type and way of creating a product, or they may ensue from other external and internal sources. Furthermore, their market aspect may be analyzed, in which they adopt the form of technical innovations[1] perceived as "change of technology that is introduced for the first time into the production process".[2]

With respect to its subject, innovation is most thoroughly defined by Schumpeter, according to whom it includes[3]:

- introduction of a new product (or modification of the already existing one);
- introduction of a new production method;
- new market in which a certain branch was previously not present,
- obtainment of new sources of raw materials or half-products, regardless of whether this source has already existed or is entirely new;
- changes in market organization.

According to Schumpeter, the innovation in its time perspective is a primary realization of the invention which is at its basis, i.e. implementation in economy. Schumpeter divides technical changes into the so-called Schumpeter's triad:

- invention,
- innovation,
- imitation.

Invention requires certain input (technology-input); afterwards it is transformed into a technical product in the form of innovation in processes and products (technology-output) and is then distributed in the entire company, branch, economy and

[1] In this case, innovations are market reflection of technical advancement.

[2] Compare: E. Mansfeld, *Innovation, Technology and the Economy*, E. Elgar, Aldershot 1995, p. 473.

[3] Compare: J.A. Schumpeter, *The Theory of Economic Development*, Galaxy Book, New York 1932, p. 66.

world (diffusion)[4]. The dimension of invention is measured on the basis of the sum of outlays on R&D (research and development works), in case of innovations – the number of implementations, whereas diffusion is valuated by taking into consideration the number of companies using a certain solution.

Innovation-related activity ought to be related to adopting methods that have not been used previously. Difficulties in realizing technical innovations contribute to the fact that they may be defined as every change in production methods of a company, regardless of whether the new method was used elsewhere or not. To a certain extent, it reduced the difference in the possibilities to assess efficiency of a certain solution. However, in contemporary economy dominates the view implying the necessity to make innovations that comply with the tendency of economical inputs. Therefore, one may claim that innovation approach should aim towards a more restricted way of using resources in production processes. It is compatible with the conditions of the concept of sustainable development[5], and it is also consistent with the character of knowledge-based economy.

Companies prefer innovations in products. It ensues from the possibility of increasing competitiveness and dominance in the growing number of markets or remaining in these markets. In the conditions of strong competition, they strive for maintenance of company's position and longevity, which would be impossible without product innovations. Owing to the character of satisfied needs, product innovations may be divided into novelties in production means and consumption objects.

It appears that both types are equally important. However, a special role in contemporary economy is ascribed to novelties in the domain of consumption articles that satisfy material and spiritual needs of man. Thus, in relation to them, production goods should have a subordinate character.

Innovation approach is perceived as one of the key driving forces of economic development. It creates the possibilities of occupying gradually better positions in the international division of work, reaching extraordinary profits or creating conditions for social changes. Introduction of innovations has very complex and multidimensional impact on society through development of entrepreneurship, creation of new markets, increase in unemployment as well as high productivity of used resources.

Moreover, innovation approach is manifested in constant changes in terms of proportions of used production factors and in quality changes of these factors. On the one hand, it leads to advancement of goods, ascribing new practical features to them and lowering production costs per unit. On the other hand, it triggers the appearance of innovative products. Accumulation of knowledge and experiences and also mastering

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[4] Compare: J.A. Schumpeter, *Business Cycles, A Theoretical, Historical and Statistical Analysis of Capitalist Process,* vol. 1, Porcupine Press, London 1939, p. 93-95.

[5] Compare: D. Kiełczewski, *Konsumpcja a perspektywy zrównoważonego rozwoju*, UwB Białystok, 2008, p. 34-46.

of new technologies enables acceleration of these processes simultaneously with larger structural profits and profits of production scale[6].

Innovation results, which are beneficial for the rate of economic growth, may be presented through the prism of activity run by companies implementing these innovations, as well as competitiveness of the entire economic system. Therefore, they reflect both macroeconomic and microeconomic effects in several aspects[7]:

- as a physical aspect of innovation – new products (more profits for innovators, more effective production, higher level of income and higher living standard of social life) or production processes (higher productivity of production factors, lower absorbency of outlays);
- through increase in productivity, the result of which is lower average cost of production;
- through lower average cost which increases reimbursement rate from investments and leads to the development of companies.

With reference to the Schumpeter's theory, this classification shows innovations as technical and organizational changes leading to reaching a new, more beneficial state. From the perspective of the analyzed problem it is of greatest importance to grasp the essence of technical changes included in the processes and products and their influence on society.

Classical economists (Malthus, Ricardo) developed theories of economic growth in which the dominating production factor was land. Increase in the resources of knowledge led to the increase in production. However, it was compensated by the increase in population, as the result of which society's living standard increased.

Malthus's population theory had more biological than economic character because increase in consumption led to the increase in fertility rate and decrease in mortality rate. The model, however, did not take into consideration usefulness and impact, that the decisions made by individuals had on the number of children. Publications by G. Becker, K. Murphy, R. Tamura[8] or R. Lucas[9] introduce Malthus's assumptions into the neo-classical model including usefulness of household, in which, according to G. Becker, there is compromise between the quantity and quality of people.

Such an approach specifies a size of population by institutional arrangement and state policy. Preferences of households refer only to non-consumption decisions and

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[6] Compare: W. Krelle (ed.), *The Future of the World Economy. Economic Growth and Structure Change*, IIASA Springer Verlag, Berlin 1989, p. 22.

[7] Compare: G. Rosegger, *The Economics of Production and Innovation. An Industrial Perspective*, Pergamon Press, Oxford, 1986, p. 204.

[8] Compare: G. Becker, K. Murphy, R. Tamura, *Human Capital, Fertility, and Economic Growth*, "Journal of Political Economy", No. 98, 1990, p. 27-30.

[9] Compare: R. Lucas, *Lectures on Economic Growth*, Harvard University Press, Cambridge 2002, p. 19-32.

do not take into account the number of offspring, which is an exogenous factor. Another assumption, which ensues from aforementioned conditions, concerns stable living standard.

At the beginning of the 21st century, more advanced economies experience considerable socio-economic changes. Technical and information revolution creates new sectors based on biotechnologies, micro processors and telecommunication, which contribute to different approaches to the issue of production and entrepreneurship. Innovation wave caused the emergence of new relations between a consumer and a producer, new ways of acting, control of quality and formation of production units. Market economies are in the process of another cycle of Schumpeter's "creative destruction".

Technical progress "triggered" this type of changes that accelerated along with continuing liberalization of global economy. Simultaneously with reduction in the costs of transport and communication, more liberal trade and elimination of financial restrictions there was observed greater flow of goods, services and capital between economies. This growth was reflected chiefly in the flow of direct foreign investments (DFI). All economies became more open than they were 20 years ago, whereas larger competition forced their more innovative character[10].

Contemporary wave of innovations led to considerable quality-related changes in global economy. Decrease affected absorbency of production in terms of used materials and energy. Over the last two decades, the rate of growth of global production is higher than the rate of used raw materials and energy. It means that economic growth takes place in the conditions of negative income elasticity of demand for natural raw materials and energy carriers, thus leading to lower demand for these goods in global economy and reducing turnover of countries specializing in exporting them.

There was observed reduction in importance of cheap workforce as the source of comparative advantage. Differences in respect of remunerations in particular countries have long been the factor deciding upon localization decisions in global economy. It was a beneficial situation for countries that specialized in traditional and time-consuming areas. In the 1980s more advanced countries began to use on a large scale automatic technologies in traditional branches of industry (clothing, textile, shoe, metallurgical, installation of applied electronics and production of cars). As a result, these branches become intensive in technical and capital terms. It leads to their development and functioning even in those countries where working costs are high. In these conditions, advanced technologies become the substitute of cheap workforce offered by developing countries.

[10] Compare: S. Berger, R. Dore (eds.) *National Diversity and Global Capitalism*, Cornell University Press, New York 1996.

A combination of innovations in the domain of calculation technology and data transmission (Internet) reduces costs and time of communication. Moreover, distance between people and societies is reduced, owing to which a global information network is created. It creates a new quality because information becomes a production factor (on equal terms with work, capital and material natural resources) that has impact on the position of particular countries in global economy.

Owing to diffusion of technical progress, there is observed equalization of technical skills in companies located in various countries, and technical parity increases. On the level of countries, one may observe a similar tendency, which is defined as technical convergence. In the process of technical progress diffusion, the leading role is ascribed to transnational corporations because of geographical integration of diffused R&D operations and owing to ordering them to the global strategy of their parent company.

Despite the occurrence of the aforementioned phenomena, global innovation potential is very diversified in spatial terms. There are technological gaps between highly developed and developing countries, which is manifested in the coexistence of economic entities, production techniques and products representing various levels of technical advancement. Technological gaps constitute a component of competition on the market, creating conditions for leading companies or countries to take advantage of technical advantages. At the same time there appear incentives to imitate innovation processes and transfer of technologies.

Dissimilarity of economic systems (liberal and controlled by the state) changes the attitude to the fundaments of conventional glance at international character of innovations. The effect of institution shapes various models of companies' functioning. Simultaneously, the companies automatically do not transfer their activity where the working costs are lower because these not always guarantee an adequate level of qualifications and efficiency. Institutional advantages are frequently more important than reduction of remuneration costs.

Uneven and multidirectional character of technological economic growth is typical of developing countries. Because the diffusion process of technical advancement takes place in a more gentle way, the process of catch-up for the Western Europe and Japan takes place more smoothly than in American economy. The reason is that economic systems of these countries are prepared better for using technical globalization[11]. Technological convergence takes place in a much more efficient way in economic systems with well developed internal structures comprising financial market, capital market, production, employment, institutions and economic openness. However, the effective course of the catch-up process does not eliminate technological

[11] Compare: R. Nelson, *Why Do Firms Differ and How Does It Matter?*, "Strategic Management Journal", No.12, 1991, p. 121.

loopholes, thus creating thus new possibilities for searching for competitive advantages and enabling continual development of technical progress[12].

2. Market Changes in markets and institutions versus innovation approach in knowledge-based economy

Innovation approach imparts dynamism to the activity of companies implementing innovations also in ecological aspect. This process reflects both macroeconomic and microeconomic effects, which decides upon competitiveness of the entire economic system in which innovative entities function.

Companies do not begin their activity automatically when production costs are lower because this factor not always has impact on effectiveness of the innovation process. What contributes to this situation is lack of access to appropriate resources of knowledge or qualifications as well as shortage of suitable institutional conditions that create the relations between entities characteristic of the given economy. Institutional advantages frequently become more important than reduction of costs.

The last decade of interest in nature and the reasons for economic development proves that the process of innovative catch-up is not autonomous but dependent on tangible and intangible investments in education, knowledge, R&D activity and similar activities[13]. These factors became the basis for success achieved by some developing countries, as regards reduction in technological gap. It ensues from lack of both automatic action and international diffusion of innovations[14]. Material factors and knowledge used for development have various limitations and range of action, which reduces their effectiveness. Basic knowledge is extended by experience and processes of *learning through action* or *learning through routine*[15], which is then widespread in the form of trainings, new forms of activity or experimental research. In economy there are differences in terms of accumulation of technical knowledge, which lead to emergence of technological gaps specifying various levels of companies' development.

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[12] Compare: M.V. Posner, *International Trade and Technical Change*, "Oxford Economic Papers", Vol. 12, 1961; compare: R. Vernon, *International Investment and International Trade in the Product Cycle*, "Quarterly Journal of Economics", Vol. 80, No. 2, 1966.

[13] Compare: J. Fagerberg, *International Competitiveness*, „Economic Journal", Vol. 98, No. 2, 1988, p. 102-104.

[14] Compare: M. Bell, K. Pavitt, Technological Accumulation and Industrial Growth: Contrasts between Developed and Developing Countries, "Industrial and Corporate Change", No. 2, 1993, p. 168-170.

[15] Compare: G. Dosi, D.J. Teece, J. Chytry, *Technological Organization and Competitiveness. Perspectives on Industrial and Corporate Change*, Oxford University Press, 1998, p. 290-292.

In the last decades, companies transferred their activity to countries in which costs were lower because they anticipated considerable reduction in prices. Presently, in the period of *knowledge-based economy*, companies pay more focus on development of intangible captal, which becomes the most effective method of competition. Additionally, competitiveness level became more dependent on R&D and innovations, intellectual property, value creation, i.e. on technological extent of production processes' development[16].

It is worth observing that in the conditions of *knowledge-based economy*, radical innovations, which support sustainable development and consumption (e.g. actions leading to increase in resources' productivity with the purpose to reduce emission of carbon dioxide), implicate emergence of new forms of innovative activity[17].Innovative activity and conditions of sustainable development create specific mechanism that reflects the essence of their functioning in more general conditions of social development.

The analysis of hitherto observed changes in economic systems and consumption processes shows that it is difficult to renounce once and for all the existing ways of producing goods and adjust them to the requirements of sustainable development[18]. The literature devoted to innovative approach shows a number of various processes that reinforce one another and create paths of technological development in accordance with certain "trajectories" that not always result in sustainable development[19]. It is linked with the fact that changes in innovation processes tend to be of increase type, and their paths depend on[20]:

- cognitive range, cognitive procedures, production skills, knowledge of producers and consumers, where one may anticipate what type of knowledge will be most advantageous in the future;
- paths of social and technological activities and the ways in which they are introduced to broader social infrastructure;
- possibilities of extending alternative solutions in production processes;
- using economy of scale (mass markets) and advantageous external links (less hazardous and easier in application);

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[16] Ming-Hsin Kung (2003), *The dynamics of Innovation in Taiwan – the Patent Analysis Respective*, a paper prepared for the conference: Industrial Science and Technology Innovation, Taipei, 30-31 October, p. 3-4.

[17] Compare: F. Berkhout, *Technological Regimes, path dependency and the environment*, Global Environmental Change, 12 (1), 2002, p. 1-4.

[18] Compare: A. Smith, *Environmentalism and Technology*, SPRU Working Papers, Brighton, IV 2006, p. 3-6.

[19] Compare: R. Nelson, S. Winter, *An Evolutionary Theory of Economic Change*, Bellknap Press, Cambridge, 1982, p. 21-37.

[20] G. Sayfang, A. Smith, *Community Action: A Neglected Site of Innovation for Sustainable Development*?, CSERGE Working Paper, EDM 6-10, p. 4.

- evolution of such institutions as: economic policy, occupational associations and institutions coordinating functioning of the market;
- universally binding market and social regularities that have impact on the type and character of activity comprising technologies and lifestyle.

Taking into consideration the aforementioned solutions enables one to define the mechanism of influence and importance of innovations for sustainable development. One may observe several aspects of functioning of such type.

Over the last two decades economists have more frequently been interested in ecological conditionings of innovation development and their impact on competitiveness in the conditions of global economy. What aroused their interest was empirical research concerning certain cases of dynamic technological development of some regions and its focus on sustainable development[21], as well as frequent and yielding good results usage of appropriate regional approach to this issue[22] in highly developed economies[23]. Presently one may observe two theoretical approaches to innovative development in the conditions of sustainable development: of cluster type and those based on regional innovation systems (RSI). Both types are very similar. However, they may not be linked with the assessment of the extent and character of innovation approach[24].

Both approaches make use of the experience of regions that achieved innovative success and attempt to use it in various places and conditions. It is not always beneficial because it does not take the specific type of the region, companies running business activity in this area and instruments of economic policy. Dichotomy of this type is significant also for pro-innovation activities of particular regions. It is connected with the importance of innovative entities. In the approach of cluster type there dominate companies whose activity is linked with implementations and possibilities of making use of technology transfer. In RSI approach the main element is pro-

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[21] Compare: B. Asheim, *Industrial Districts: The Contributions of Marshall and Beyond*, in: Clark G.L., Feldman M.P., Gertler M.S. (ed.), *The Oxford Handbook of Economic Geography*, Oxford UP, 2000, p. 413-431. Compare: A. Saxenian, Regional Advantage: Culture and Competition in Silicon Valley and Route 128, Harvard UP, 1994, p. 41-52.
Compare: E.S. Andersen, Approaching National Systems of Innovation, [in:] Lundvall B.A. (ed.), *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*, Pinter London, 1992, p. 47-59.

[22] It concerned mainly the research on clusters in Western Europe – e.g. Third Italy, or Silicon Valley.

[23] Compare: M. Porter, *The Competitive Advantage of Nations*, Billing and Sons Ltd., 1990, p. 144-148.

[24] Compare: B. Asheim, *The Role of Regional Innovation Systems in a Globalizing Economy: comparing knowledge bases and institutional frameworks of Nordic clusters*, a paper prepared for the conference: Industrial dynamics, innovation and development, Elsinore, Denmark, 14-16 June, 2004, p. 2-3.

innovative institutional arrangement and possibilities of its impact on the innovative character of companies. Institutions create innovative policy that supports R&D activity.

Making use of a certain approach to innovation evaluation is therefore linked with a selection of the character of applied innovative policy and its main purpose. This purpose may be: reaching a high level of outlays on R&D, which will enable the creation of greater innovation potential (knowledge-based economy) or reaching a higher innovation level of implementation which increases companies' competitiveness but does not develop innovative system (learning economy).

A selection of the approach is also connected with determination of innovation factors and directions in which it should aim. *Knowledge-based* approach means using taxonomy that is based on division of economy into sectors of high, medium and low technology[25]. In this case, innovative approach will be related to reinforcement of very technological branches by means of innovative policy ensuring financial support of the research.

Adversely, *learning economy* implies presentation of innovation approach in the context of an interactive process of social, territorial, cultural, institutional and economic character. The concept of innovative development implies the necessity of development of branches, companies and regions considered as innovative ones, however, not from the perspective of the level of outlays on R&D, but from the perspective of their competitiveness and local specific character. Thus, innovative development may comprise also traditional or ecological branches and use other characteristic properties of a particular region[26].

Therefore, technological development in the conditions of *learning economy* will be related to imstitutional and organizational changes that promote innovative approach. This process takes place from vertical integration to production disintegration, i.e. knowledge is diffused among companies characterized by various levels of R&D and various type of activity, and its level in a certain region ensues from accumulation of experiences gained by entities[27].

Having analyzed the character and possibilities of ecological innovations and innovative changes in the conditions of sustainable development, the approach of "learning economy" appears to be more beneficial. It enables one to take into consideration a wide range of activities having not only incremental but also evolutionary character.

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[25] OECD, *Science and Technology Indicators*, Paris 1986.

[26] Compare: B. Asheim, *The Role of…*, op. cit., p. 3-4.

[27] Compare: B.A. Lundvall, *Why the New Economy is a Learning Economy*, DRUID Working Papers 04-01, 2004, p. 1-2.

Conclusions

Innovative activity should reflect conditionings, potential and possibilities of certain areas. A strenuous process of creating conditions of a higher innovative character should combine a specific character of the area it is realized in and character of the innovation. In the case of periphery regions (e.g. Podlasie) a considerable role is played by ecological innovations that enable imparting dynamics to development and adapting traditional conditions of the region. In the future, these regions may be located in the part of knowledge-based economy or "*learning economy*".

At the heart of innovative processes should be regions, whereas a regional level ought to be perceived as essential from the perspective of real progress. Regions have already gained considerable possibilities of realizing tasks of innovative character. Regional entities are among most crucial participants of innovative activities, i.e. of companies, universities, research institutions, etc., and have a key role in the promotion of knowledge-based economy.

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