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Technological Entrepreneurship as a Factor of Development and Restructuring of the Global Economy

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Abstract

The main problem dealt with in the publication is the role of technological entrepreneurship in stimulating the processes of development and restructuring of the global economy. The purpose of the paper is to identify and analyze the factors of development and restructuring of the global economy against the background of the challenges and circumstances arising out of compliance with the criteria of sustainable and inclusive development. The paper provides an overview based on the analysis of the world literature, including the Polish contribution, as well as on the experience gained thus far by the leaders in the civilizational transformations of the last decades. The processes illustrating the emergence of a new economic map of the world were based on information concerning the ranking of the technology readiness level — i.e., the capability of an economy to absorb technologies increasing productivity of production factors. This parameter is currently the key element of the economic competitiveness of the individual states. The sources of this information were global reports issued by the OECD, various UN agencies, the World Economic Forum, as well as independent international analytical institutions. The common access to products created as a result of applying disruptive technologies implies a large number of civilizational threats of a hitherto unknown scale. It is advisable to undertake formative actions addressed to users of new devices concerning responsible use of the achievements of inventors and manufacturers of new products.

Keywords: technological entrepreneurship, disruptive technologies, technology readiness, development and restructuring of the economy

JEL: O10, O32

Introduction

In the late 1970s and early 1980s the global economy saw a radical increase in the number and significance of achievements in fundamental and applied research as well as an acceleration of the processes of implementation of new technical solutions in the sphere of production, of the nature of both minor improvements and disruptive technologies. This process manifested itself in the emergence and rapid spreading, often on a large scale, of a lot of new products, both goods and services. It is essential to emphasize that it was also in that period that definite shape was given to the assumptions, criteria and objectives of the concept of sustainable development which was then focused particularly on reducing anthropogenic pressure on the environment. This process is being carried out basically through the protection of:

- environmental resources, especially those non-renewable,
- the function of the environment, mainly such as supporting life processes, providing raw materials and energy, and also absorbing the adverse effects of man's economic and social activity, and
- the components of the environment (i.e., the air, water and soil).

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The criteria of sustainable development were initially considered constraints to the development of industrial activity, in many cases even as barriers to economic growth, yet the rationality of the requirements of the concept of sustainable development on the one hand and the nature and dynamics of the new developmental factors and processes on the other hand enabled the harmonization of even very advanced environmental, economic and social objectives. The assessment of the results of utilization of the new science and technology achievements led, over time, to recognition of the key role of technology and innovation not only in the sustainable but also in the inclusive development of industry (Pindór 2017a).[1]

1 Technological entrepreneurship

1.1 The essence of the notion of technological entrepreneurship and discussion in the literature of the subject

Since the time of J.A. Schumpeter, the marriage of entrepreneurship and innovation has been commonly considered particularly effective as it provides conditions for identifying the notion of technological entrepreneurship. Stachowicz (2015, 628) defined this category as follows: "technological entrepreneurship relates to a process of creating and developing enterprises using product and process innovations." Kordel (2014, 20, 23–26) believes that "the phenomenon of technological entrepreneurship occurs when the development of science and engineering creates the key element of the entrepreneurial chance, enabling generation of a given enterprise, market, cluster or even a whole industry" and emphasizes that "the reason and basis for the process of formulating chances are the learning processes." The process of technological entrepreneurship is also perceived as "a development strategy based on creating, discovering and exploiting technological chances." The measure of its effectiveness is the capability of transforming new technological solutions into a stream of economic benefits (Wściubiak 2011, 64).

In the monograph by Lachiewicz, Matejun and Walecka (2013, 7), the notion of technological entrepreneurship is understood to be "a process of providing greater practical usability to results of research through effective collaboration between scientific and research and development centres, institutions of the capital market, the business environment and enterprises dealing with manufacturing and selling civilisationally advanced merchandise or services." Technological entrepreneurship is also identified as a factor "integrating issues related to entrepreneurship and management of technology and innovation" (Ławecki 2014, 37). According to Rostek and Skala (2016, 155–159), "in the context of increasing the technological awareness among entrepreneurs, increasingly vital importance is attributed to the development of those entities that are saturated with modern technology and have the capability to quickly and flexibly adapt the achievements of science." The authors conducted an analysis of enterprises broken into three groups — i.e., Hi-Tech (HT) manufacturers, manufacturers deploying Key Enabling Technologies (KETs) and manufacturers operating in the branch of Information and Communication Technologies (ICT), which enabled them to identify enterprises with a high development potential.

1.2 Disruptive technologies

Both in the highly developed countries and in many of those being on the path of rapid development, disruptive technologies are, beside minor improvements, more and more commonly utilized. The original definition of this factor of economic and even civilizational development was formulated by Clayton M. Christensen, Professor of Business Administration at the Harvard Business School of Harvard University: "Disruptive technologies are such technologies which make use of innovation bringing completely new values and completely change the material and product markets" (Christensen 2010, 26–33, 288–292).

1. See also: Industrial Development Report 2016. The Role of Technology and Innovation in Inclusive and Sustainable Industrial Development. United Nations Industrial Development Organization, 2015, Vienna, [@:] https://www.unido.org/sites/default/files/2015-12/EBOOK_IDR2016_FULLREPORT_0.pdf.

In the vast literature of the subject, the cited approach to the key category of development is exceptional. For the present stage of structural transformations of the global economy, and above all for the modern orientation and mentality of business people, scientists and engineers, the predominant approach focusses on the effectiveness of the projects undertaken and on achieving the objectives in a shorter time than competitors. Thus, it is particularly valuable that Christensen mingles, in one extremely synthetic definition, such aspects of the design, investment and production activity as, different values provided by disruptive technologies (and not only a greater value of production and profit) with the essence of innovative changes — i.e., new materials and products, and economic changes manifesting themselves in changing markets.

Brynjolfsson and McAfee (2015, 15, 17, 40–42, 83–88) challenge the views expressed, among others, by Keynes, Drucker and Leontief suggesting that the role of humans as the most important production factor is being marginalized. The authors believe that digital technologies are transforming the labor market, increasing productivity and stimulating economic growth, but they do not imply the "end of work" as the designing, constructing and operating civilizationally advanced devices require a considerably longer period of education including education on university level, often at two faculties or on postgraduate courses.

The long-lasting process of preparation for professional work as well as the constant raising of the level of knowledge, skills and social competencies through postgraduate studies involves the work of an increasingly large group of teachers as well as academic lecturers and research and technical staff.

1.3 Technology readiness

An essential category in the area of the analysis of economic competitiveness is the technology readiness, which is a measure of the capability of an economy to absorb disruptive technologies increasing the productivity of production factors. The technology readiness concerns particularly those processes and technology transfer channels that trigger a flow of information promoting innovation or increasing the innovation absorption. Assessment of the technology readiness in particular countries is the subject of research carried out by the World Economic Forum. This institution publishes results of analyses of conditions for long-term economic development, conducted by an international team of experts, in an annual report entitled the Global Competitiveness Report. In the 2017 report it was announced that the leaders of competitiveness in the global scale were Switzerland, Singapore and the United States.[2]

With regard to the ranking of the technology readiness level, the World Economic Forum applies a number of detailed indicators, the most important of which include:

- availability and transfer of technology; within this indicator the assessment concerns above all the availability of the latest technologies; Poland's rank: 68th,
- national enterprises' capability of absorbing technologies; Poland's rank: 65th, and
- value of direct foreign investments enabling transfer and dissemination of new technologies; Poland's rank: 49th.[3]

The above-mentioned indicators have a decisive influence on the level of technological advancement in the countries included in the analysis of the World Economic Forum.

2 The innovative context of phenomena and processes in the contemporary global economy

The most frequently used notion describing the last four decades in the global economy is restructuring. This process has included nearly all the segments, forms and methods of economic activity

2. See: The Global Competitiveness Report 2016–2017. Insight Report by Klaus Schwab and Xavier Sala-i-Martín, World Economic Forum, 2016, Geneva, [@:] http://www3.weforum.org/docs/GCR2016–2017/05FullReport/TheGlobalCompetitivenessReport2016–2017_FINAL.pdf.

3. See: Strategia na rzecz Odpowiedzialnego Rozwoju do roku 2020 (z perspektywą do 2030 r.). Ministerstwo Rozwoju. Departament Strategii Rozwoju, Warszawa, 2017, pages 71–72, [@:] https://www.miir.gov.pl/media/48672/SOR.pdf.

as well as all the analytical levels (i.e., global and international, macro-, mezzo- and microeconomic). The leaders of the processes of structural changes in the global economy are, in the order of entering the path of profound and comprehensive restructuring the following countries: Japan, the United States, Canada, Australia, Singapore, Hong Kong, Taiwan, South Korea, countries of Western, Northern and Central Europe and the People's Republic of China (PRC).[4] The long-term trend of maintaining high dynamics of innovative economic growth and the consistent restructuring of the economic systems of the countries of the Western Pacific Coast made this region a new global pole of growth and competitiveness.

Continental China has been the global center of goods manufacturing since the late 2000s and early 2010s. The historic and essentially pivotal change of the paradigm and goal of the economy in the People's Republic of China was initiated when the pragmatic wing of the political leadership of the state adopted and announced the slogan "Get rich!" in 1978. After the over forty years long period of destroying any forms of a free-market economy, this appeal sounded shocking but the Chinese, pragmatic and extremely loyal to the central authorities, treated the new conditions as a chance for a radical change of material status and were determined to take up the challenge of building a new economy. The main factor of the economic growth in China in the late 1970s and early 1980s was internal demand, created by the policy of the state, focused on two areas, urbanization and industrialization. The 1990s saw the beginning of the process of displacing several hundred million people from rural areas, deprived of the access to electricity, running water and sewage systems, to urban centers where they were able to take advantage of all the achievements of modern civilization and employing the new urban dwellers, mainly in the sector of goods manufacturing.[5]

A highly significant factor in innovative technological development, which is actually a prerequisite for taking advantage of the above-mentioned impulses stimulating the economic processes, is the spread of education on a global scale, and in countries with the highest demographic potential (i.e., the PRC and India, also a quick increase in the number of students).[6]

A distinctive feature of these changes is moreover a surge in the number of students in such fields and disciplines as science, all kinds of engineering and information technology. A new phenomenon in university education in many countries, including Poland, is creating substantive, procedural and technical conditions for pursuing inter- and multidisciplinary studies, particularly in such fields as physical chemistry, physics and environmental engineering, biotechnologies, nanotechnologies, mechatronics, biomedical engineering, management of mineral resources of the seabed and ocean floor as well as submarine resources of primary energy sources, hydrogen economics, nuclear technologies and advanced technologies for exploiting renewable sources of energy (Pindór 2017b).[7]

3 The place of technological entrepreneurship among the factors of development and restructuring of the global economy

The essence of the development and structural transformations of the global economy at the turn of the century and millennium can be identified as the synergic effect of multiple phenomena and processes of an unprecedented scale and dynamics. This paper distinguishes two major groups of factors of development and restructuring (i.e., institutional, organizational and logistic as well as technological). Furthermore, it identifies the internet as the key factor of access to knowledge, information and interpersonal communication, and also of building an economy based on digital integration of production systems using the Internet of Things.

4. See: The Global Competitiveness..., op. cit., pages 325–336.

5. See: China Tech Market Outlook for 2017 To 2018. Business Technology Accelerates Digital Transformation in China. Report by Charlie Dai et al., 24 January 2017, Forrester Research, Inc.

6. See: Societal Implications of Nanoscience and Nanotechnologies, UNESCO Report, 2016

7. See also: China Tech Market..., op. cit.; OECD Science, Technology and Innovation Outlook 2016. Paris, 2016, [@:] https://www.ewi-vlaanderen.be/sites/default/files/bestanden/oecd_science_technology_and_innovation_outlook_2016.pdf.

3.1 The institutional, organizational and logistic factors

The main institutional, organizational and logistic factors of development of manufacturing techniques and technologies, and then implementation of the new development factors of manufacturing processes include:

- development of research and development work, in the range of both fundamental and applied research, by concentrating the research and technical staff as well as financial and physical capital in numerous universities, development departments within corporations and in, typically newly established, centers carrying out international research and implementation programmes;
- transfer of military solutions created as a result of public procurements during the cold war period, mainly by the American Defense Advanced Research Projects Agency (DARPA) for wider use;
- internationalization of the processes of designing new development projects and new products with a significant predicted potential for creating new international markets;
- introduction of effective procedures for commercialization of inventors' and designers' achievements thanks to collaboration between research institutions and industrial enterprises, which made it possible to rapidly achieve a large scale of production and sales, which in turn resulted in a reduction of the manufacturing unit costs and thereby of the prices offered as well as to significantly reduce the period of return on the investments involved;
- effective protection of intellectual and industrial property; and
- technology foresight research serving the purpose of identifying the key technologies of the future, evaluating the opportunities and threats arising from their application as well as creating development scenarios for selected technologies ("Platforma Przemysłu..." 2017; Bąk and Kulawczuk 2009; Mazzucato 2016).[8]

3.2 Technological factors

Technological entrepreneurship manifests itself particularly in such innovative development efforts as:

- computerization of manufacturing processes enabling ongoing monitoring of the technical and economic results of production;
- computerization of products, especially consumer durables, utilized by users to control, often remotely, the technical parameters of operation of such devices;
- automation of manufacturing and services drastically improving productivity, especially with regard to repeated operations, and the productivity of physical capital, above all of machines and manufacturing devices, and also of transport and logistics in the entire value-added chain;
- robotization of manufacturing processes determining economically effective introduction of flexible production systems;
- utilization of nanotechnologies for manufacturing nanomaterials (i.e., plastics with previously unknown properties, including disruptive ones);
- 3D printing technology (i.e., the process of creating physical, three-dimensional objects based on a computer model); or
- international transfer of knowledge (Mikulczyński, Samsonowicz, and Więcławek 2017)[9]

3.3 Digital integration of production systems

A qualitatively new solution turned out to be the worldwide system of connections between computers using the telecommunication infrastructure. The internet opened up possibilities unknown in the history of civilization for interpersonal communication as well as universal access to huge resources of knowledge and information, and now it is becoming the fundamental growth factor of the effectiveness of manufacturing and service processes.

8. See also: OECD Science, Technology..., op. cit.

9. See also: 2017 Annual Report. Transforming Business, Making Life Simple. TechnologyOne, [@:] https://www.technologyonecorp.com/__data/assets/pdf_file/0011/67691/TechnologyOne_2017_AnnualReport.pdf; Nanotechnology Market Reports from year 2017, published by ReportLinker, at https://www.reportlinker.com/; World Robotics Report 2017. International Federation of Robotics.

As a matter of fact, the internet is a network of networks, and this feature gives new quality to the manufacturing processes based on the synergic effects of using network communication. The essence of these solutions is the Internet of Things—i.e., digital integration of production systems and creating digitally controlled networks of autonomous machines and sensors. The internet as well as other IT solutions is used to provide communication between these devices and also with the people who supervise their operation. Autonomous processing and transmission of information necessary to control the manufacturing process constitutes the essence of the changes identified as the fourth industrial revolution or "Industry 4.0." This process signifies the transition from the stage of automation and robotization of industrial production to the phase of mechatronization of production and products—i.e., computerized remote online management of all the phases of manufacturing in the entire technology and product lifecycle comprising the aspects of design, investment, production and environment (Olszewski 2016, 18). The great, even global, scale of utilization of the key technical achievements, such as personal computers and especially mobile telephony, used even in poor communities that were previously considered permanently excluded from the benefits of the civilizational transformations, has transformed the lives of billions of people.

It should be stressed here that the universal accessibility to new devices has brought a lot of adverse effects, particularly in recent years when numerous phenomena which are in nature a threat to civilization have manifested themselves. What is particularly worrying is that millions of people seem to be addicted to constant use of electronic devices intended for social communication as well as that 3D printing is on more and more occasions used by criminals, mainly in order to illegally manufacture arms and to counterfeit branded products.[10]

Conclusion

- Technological entrepreneurship enables us to obtain the synergic effect of combining technological knowledge with innovation and also with the ability to identify and take advantage of opportunities, and with willingness to take risks.
- Technological entrepreneurship is the key factor of sustainable and inclusive development, and also of structural transformations of the economy.
- Inter- and multidisciplinary knowledge as well as the intellectual factor and passion for discovery make up the hybrid path for creating disruptive technologies.
- The most important effects of the implementation of disruptive technologies and materials include the following:
  - reduction of the rate of consumption of materials, including raw materials, and energy in manufacturing processes
  - reduction of unit costs of production and consequently of the prices of products manufactured using innovative technologies
  - increasing the demand for innovative products
  - reduction of anthropogenic pressure on the environment by reducing the rete of depleting non-renewable mineral resources and primary energy sources despite the great scale of production
  - reduction of the level of environmental threats, particularly with regard to the functions and components of the environment
  - rapid dissemination of technical and technological achievements
  - provision of common access, thanks to the internet and on the global scale, to such factors of development as:
    - information and knowledge, including new knowledge and databases,
    - technical capabilities of social communication, and
    - digital integration of production systems.
- An essential category in the area of analysis of economic competitiveness is the technology readiness, which is a measure of the capability of an economy to absorb technologies increasing the productivity of production factors.

10. See: Societal Implications of Nanoscience and Nanotechnologies, UNESCO Report, 2016, page 86.

- In the race against machines, even the most intelligent ones, entrepreneurship will continue to be man's most important asset; therefore, it is worthwhile to develop this feature and make sure that at least this one attribute remains in the human domain in the world of almighty automates and robots.
- The historical changes taking place in the PRC are essentially the effect of the transformation of the society's mentality, from disciplined but passive executors of commands into dynamic and creative entrepreneurs.

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