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KNOWLEDGE ECONOMY: FEATURES AND INDICATORS ANALYSIS

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Abstract

The article reveals the essence of the knowledge economy and identifies problematic aspects in its theoretical justification. The author proposes his own definition of the knowledge economy based on the analysis of different approaches to defining the concept. The article highlights the role of innovation, science, and education in shaping the knowledge economy. It also points out the complexity of assessing the level of development of the knowledge economy due to the lack of a comprehensive approach to quantifying accumulated and created knowledge. The article emphasizes the importance of growing inequality caused by the lack of access to knowledge through quality education and digital technologies in certain regions. The labor market in the context of the knowledge economy is characterized by unstable labor relations. The author proposes an assessment based on key indicators (aspects), such as the Global Knowledge Index, the Global Innovation Index, the Human Development Index, the scientific content of GDP, the number of applications for patent cooperation agreements, and the cluster approach to economic development, which allow for the assessment and determination of the level of development of the knowledge economy in different countries. Special attention is paid to analyzing China's experience in building a knowledge-based economy. The author covers government policies to support high-tech industries, the combination of planning and market incentives, and the development of large-scale national programs. It emphasizes China's leadership in ICT development, increased investment in science and education, the importance of human capital, and the creation of innovative clusters and venture capital ecosystems. The author presents a comparative analysis based on key indicators, which helps to identify key differences and determine areas for development.

Keywords: knowledge economy, innovation, indices, science intensity, patents, clusters.

ЭКОНОМИКА ЗНАНИЙ: ОСОБЕННОСТИ И АНАЛИЗ ПОКАЗАТЕЛЕЙ

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Реферат

В статье раскрыта сущность экономики знаний и определены проблемные аспекты в ее теоретическом обосновании. На основе проведенного анализа разных подходов к определению понятия, автор предлагает собственное определение. Отмечается роль инноваций, науки и образования в формировании экономики знаний. Также указывается сложность оценки уровня развития экономики знаний по причине отсутствия комплексного подхода в количественной оценке накопленных и создаваемых знаний. Отмечается важность роста неравенства по причине отсутствия доступа к знаниям посредством качественного образования и цифровых технологий для отдельных регионов. Рынок труда в контексте формирования экономики знаний характеризуется нестабильностью трудовых отношений. Автором предложена оценка на основании ключевых показателей (аспектов), таких как глобальный индекс знаний, глобальный инновационный индекс, индекс человеческого развития, наукоемкость ВВП, число заявок на договора о патентной кооперации, кластерный подход формирования экономики, которые позволяют оценить и определить степень развитости экономики знаний в странах мира. Особое внимание уделяется при анализе опыту Китая в построении экономики знаний. Интерес представляет государственная политика поддержки высокотехнологичных отраслей, сочетание планирования и рыночных механизмов стимулирования и развитие масштабных национальных программ, отмечается лидерство Китая в развитии ИКТ, рост инвестиций в науку и образование, первостепенная роль и развитие человеческого капитала, создание инновационных кластеров, создание венчурных экосистем и др. Автором представляется сравнительный анализ по показателям предложенным в качестве основных, который позволил выявить ключевые диспропорции, которые и позволяют выявить проблематику и определить направления развития.

Ключевые слова: экономика знаний, инновации, индексы, наукоемкость, патенты, кластеры.

Introduction

The theoretical foundations of the role of innovation in the formation of the knowledge economy are laid in the works of D. Bell, J. Galbraith, P. Drucker, E. Toffler, J. Quinn, R. Rich, F. Machlup, J. Schumpeter, S. Kuznets, F. von Hayek, G. Becker, P. Krugman, K. J. Arrow, D. North and others.

Scientific publications by Russian and Belarusian researchers, in particular A. V. Bondar, K. I. Ryabova, K. S. Okrut, K. I. Zhukov, Z. O. Adamanova, E. A. Borodavko, N. O. Vasetskaya, S. V. Chirikov, V. Z. Yampolsky, N. R. Kelchevskaya, I. M. Chernenko and others also play an important role.

In the current conditions of socio-economic development, knowledge, information, human and intellectual capital have become key factors, which determines the relevance of the study and its theoretical significance. This has been facilitated by globalization and the challenges it has brought, as well as the processes of digitalization, scientific and technological progress, and the transformation and complexity of the production and consumption processes.

The theoretical foundations of the knowledge economy and the system of indicators for assessing development

The concept of the knowledge economy was first introduced by the Austrian-American economist Fritz Machlup in 1962 in his work "The Production and Distribution of Knowledge in the United States" [1]. The researcher defined the knowledge economy, provided a classification of knowledge and methods for its production, highlighted the role of invention and patent protection, the role of education, and more.

In the 1970s, P. Drucker in his book "The Age of the Discountity: Guidelines to Our Changing Society", analyzed the role of knowledge as a resource. He introduced the concepts of the knowledge economy and the knowledge-based society, and examined the impact of knowledge on enterprise productivity and, consequently, product competitiveness. He also noted the role of innovation and entrepreneurship [2]. G. Kleiner defines the knowledge economy "as economic state in which knowledge becomes a full-fledged commodity; any commodity embodies unique knowledge; and knowledge becomes one of the main factors of production" [3].

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Alvin Toffler highlights knowledge as the most important economic resource, arguing that its production "becomes the driving force of a country's and society's development" and the engine of progress. He emphasizes that knowledge takes on a commodity form, which can be sold and profitably exploited [4].

V. V. Glukhov notes that the knowledge economy can be viewed as a system that integrates theoretical concepts, a set of practical achievements, and a set of methods for creating conditions conducive to research activities [5].

V. L. Makarov points out that in a knowledge economy, "knowledge, skills, and abilities of workers play a crucial role in the production and distribution process". This highlights the importance of skilled labor [6].

G. B. Kleiner emphasizes that the knowledge economy is characterized by the transformation of knowledge into a full-fledged commodity and the development of a knowledge market alongside traditional markets for natural resources, labor, and capital [7].

A. V. Bondar defines the knowledge economy as an economy in which knowledge acquires the status of the main economic resource, which is present in every type of economic activity, and its accumulation and effective use ensure high rates of economic growth, development of economic entities, and the entire society [8, p. 29].

The World Bank experts have proposed the following definition: "A knowledge-based economy is an economy in which knowledge is the main driver of economic growth" [9].

In our opinion, a knowledge-based economy is an economy in which knowledge is the main factor of production, embodied in intellectual capital and serving as a source of innovation, leading to the dominance of knowledge-intensive services and high-tech manufacturing.

Thus, the concept of "knowledge economy" is currently being studied and transformed under the influence of modern trends, and is being researched within the framework of various scientific schools and methodological traditions. The diversity of theoretical approaches is due to the various aspects inherent in the concept under analysis, including the role of knowledge in production, its institutionalization, the impact on global processes and the transformation of social and labor relations, as well as the changing forms of employment and the role and influence of innovation on the formation of the knowledge economy.

However, the problems that accompany the study of the knowledge economy relate to the definition and change of knowledge, and it is still unclear what exactly should be considered knowledge (applied R&D, technologies, software products, and the skills of workers, etc.) and what indicators would be appropriate for measuring it. There is no real way to quantify the accumulated knowledge and the knowledge created over certain periods of time. Additionally, the study of the knowledge economy raises fundamental questions such as the growing global inequality, where knowledge is generated in developing countries and benefits are reaped by developed countries. Social and economic inequality is also evident in the availability of quality education and digital technologies. In turn, the labor market in the knowledge economy is characterized by unstable labor relations.

Based on the generally accepted understanding of the essence of the knowledge economy, the possibility of its development is formed due to a high level of education, science and innovation. The government, which focuses on building such an economy, increases spending on scientific research, modernizes the education system, and introduces the concept of "lifelong learning." Scientists have noted an increase in the number of intellectual workers, support for high-tech and knowledge-intensive industries and the development of innovative activity of business entities. There is an active growth in the field of ICT, and a high share in the structure of the economy belongs to the service sector.

The knowledge economy is most characteristic of developed countries such as the United States, Germany, the United Kingdom, and France, as well as countries in East Asia, such as the Republic of Korea, the People's Republic of China, and Japan, where the production of knowledge-intensive and high-tech products is the primary source of economic growth [10, p. 8].

The Global Knowledge Index (GKI) is a tool for knowledge and development, and serves as a comprehensive framework for measuring the effectiveness of knowledge use worldwide. It consists of seven sub-indices: pre-university education; technical and vocational education and training; higher education; research, development, and innovation; information and communication technologies; economic development; and a supportive environment conducive to a knowledge-based climate. This indicator assesses the creation of knowledge, the quality of its dissemination, and its application.

According to the 2024 Global Knowledge Index, Sweden (index 68,3) topped the list of 141 countries in the knowledge index report. Finland (index 68) came in second place, Switzerland (67,9) came in third place, and Denmark (66,8) came in fourth place. It is worth noting that the top ten also includes the United States (66,2) and the United Kingdom (65,8). Hong Kong (China) took 29th place (60,1), the UAE took 26th place (60,9), China took 49th place (51,6). The Republic of Belarus took 50th place in this index (51,4 %), overtaking the Russian Federation (61st place) and Kazakhstan (72nd place) [11].

The Global Innovation Index provides the most comprehensive comparison of countries focused on knowledge-based economies in the technological sector. In 2024, as in 2023, Switzerland (67,5), Sweden (64,5), and the United States (62,4) remained at the top of the ranking. Switzerland is characterized by effective business policies and a high number of patent applications. Sweden also has unique approaches to business development, knowledge-intensive employment, and the number of researchers per capita. The United States is characterized by the largest amount of venture capital raised and a high level of investment in R&D. The three leaders are followed by the United Kingdom (61,0), Finland (59,4), Germany (58,1), and China (56,3). Among the post-Soviet countries, Estonia (52,3), Lithuania (40,1), Russia (29,7), and the Republic of Belarus (24,2) have the best results [12].

Comparing the Global Knowledge Index and the Global Innovation Index, we can conclude that the Republic of Belarus has high scores in the former, but low scores in the latter (unlike China and Russia, for example). This indicates that there are disparities in the level of human capital development and its effective application in science and innovation. The reasons for these disparities lie in the difficulties of transforming knowledge into innovation. If we compare the economies of Belarus and China, the problem lies primarily in the scale of the economies and the amount of investment in R&D, the formation and level of domestic demand, and the ability of the economy to be diversified. It also depends on the level of the country's innovation ecosystem (including venture capital investments, developed clusters and technology parks, and the degree of collaboration between science and business for the commercialization of knowledge), as well as its integration into global value chains. These findings are supported by the Human Development Index and the science intensity of GDP, as shown below.

According to the United Nations Development Programme's Human Development Report 2025, the countries with the highest Human Development Index (a composite measure of average achievements in the three main dimensions of human development: long and healthy life, access to knowledge, and a decent standard of living) are Iceland (0,972), Norway (0,970), Switzerland (0,970), Germany (0,595), Sweden (0,959), and Austria (0,955). The UK ranks 13th (0,946), the US ranks 17th (0,938), and China ranks 78th (0,797). For Belarus, the Global Human Development Index in 2025 was 0,824 (65th place among 193 countries) [13].

An important indicator of the development of science is the level of national R&D spending, or the science intensity of GDP, which represents the share of research and development costs in a country's GDP. It is worth noting that Israel and South Korea are the leaders in this indicator in 2024 (5,56 % and 4,93 %, respectively), in the United States (3,46 % of GDP). Among other countries developing a knowledge economy, high values of science intensity are typical for Sweden (3,42 %), Japan (3,3 %), the UK (2,91 %), China (2,43 %), France (2,22 %), the UAE (1,5 %). The Republic of Belarus is characterized by a relatively low share of R&D spending in the country's GDP (0,48 %), which is also observed in Argentina and Romania (0,52 and 0,47 %, respectively). At the same time, among the neighboring countries, only Poland (1,44 %) and Lithuania (1,11 %) reached a science intensity indicator exceeding the critical level of economic security (1 %) in 2024, surpassing Russia (0,94 %) and Latvia (0,74 %) in this indicator [14].

Investing in research and development is a key mechanism for creating competitive advantages through the creation of innovative products,

processes, and services. These developments, which have the potential for patentability, not only provide technological leadership but also create a sustainable barrier to competition, limiting the ability of other market participants to replicate the innovations.

Patent activity is another indicator of innovation activity and technological development in countries. In 2023, the number of patent applications worldwide exceeded 3,55 million. China's Patent Office received approximately 1,64 million applications. The United States, Japan, the Republic of Korea, and Germany followed suit. China accounted for 46,8 % of the global patent volume [15].

In 2024, about 273,900 international applications for Patent Cooperation Treaties (PCTs) were filed, which is 0,5 % more than in 2023. The top 10 countries accounted for 88,1 % of all applications in 2024. Candidates from China and the United States filed applications primarily in the field of computer technology. Japan filed applications primarily for electrical equipment, while the Republic of Korea filed applications for digital communications [16]. There are no data on the Republic of Belarus in the report on Patent Cooperation Treaties (PCT).

One of the promising areas of innovative development in foreign regions is the cluster approach. The economy formed within the framework of the cluster approach is a new model of innovative socio-economic development [17, p. 253]. A regional innovation cluster is a set of economic entities of various forms of ownership located in the region that create and disseminate new knowledge, products, and technologies, as well as the organizational and legal conditions for their business operations, which are formed through the implementation of regional science and innovation policies. Clusters involve the synergy of the entrepreneurial sector, education, and research centers to share knowledge, reduce transaction costs, develop joint innovation projects, and access human resources. The experience of leading countries in innovative development (the United States, Japan, China, Germany, etc.) suggests that cluster mechanisms can provide the necessary foundation for transitioning to an innovative economy through the synergistic effects of their operation.

Innovative clusters in the field of education: Stanford University, Cambridge University, Harvard, Oxford, etc. They produce more scientific publications and attract venture capital investments.

Innovative clusters in the economy: Huawei (Digital Communications) China, Mitsubishi Electric (Computer Technology) Japan, Google (Computer Technology) USA, BOE Technology (Digital Communications) China, Samsung Electronics (Digital Communications) South Korea, Panasonic Startup (Electric Machines, Appliances, and Power) Japan, Z-Park Boston Innovation Center (Medical Technology) USA [18].

Among the top 100 science and technology clusters, the Tokyo – Yokohama cluster (Japan) is leading. It is followed by the Shenzhen – Hong Kong – Guangzhou cluster (China and Hong Kong, China). Both clusters are ranked first and second.

In China, the Shenzhen – Hong Kong – Guangzhou cluster is one of the world's leading centers of scientific and technological innovation, located in the Greater Bay Area of Guangdong – Hong Kong – Macau (GBA). According to the World Intellectual Property Organization (WIPO) for 2024, this cluster ranks second in the world in terms of the concentration of scientific and technological achievements. This cluster is a prime example of the synergy between high-tech manufacturing, science, startup culture, and cross-border cooperation [18].

Shenzhen is rightfully called the "Silicon Valley" of China. This city is a hub for startups and tech giants, home to companies such as Huawei (telecommunications, AI, chips), ZTE (telecommunications), DJI (leader in drones), BYD (electric vehicles, batteries) [18].

Hong Kong is an international financial center with a focus on logistics, medicine, biotechnology, and scientific research. Guangzhou is an industrial and logistics hub that is developing in the fields of biomedicine, AI, and new materials.

In China, the knowledge economy is officially recognized as a national development strategy based on strong education. The number of Chinese students is growing in the world's top universities, and the country is establishing a national system for promoting scientific and technological innovation, which is the natural foundation of the knowledge economy [19].

The government has decided to strengthen its role in the development of the knowledge economy. China aims to encourage increased spending on research and development, promote intellectual property development, and expand the digital economy [19].

The plan includes development in priority areas of science and technology, growth of research projects, support for science-intensive business, effective regulation of the sphere of intellectual property, provision of tax benefits for companies engaged in scientific research and development, and also the stimulation of researchers to work. Presumably, the effect can be given by attracting scientists from all over the world to global innovation centers in Beijing, Shanghai, Hong Kong.

An important aspect of the policy on the development and popularization of the knowledge economy is to increase scientific literacy in society, allow for the development of various forms of employment, focus on the creative development of society, and create conditions for creative professions and non-standard teaching methods [20].

One of the most prominent initiatives is the "Made in China" strategy, which aims to modernize China's manufacturing base by automating processes, using artificial intelligence, and adopting green technologies [19].

As part of its strategy, China is using supportive financial policies. The government is committed to improving transportation, energy, and digital infrastructure. The Belt and Road Initiative is an example of this.

China is a globally competitive producer of technologically complex goods, such as telecommunications equipment, machinery, computers, solar panels, high-speed railways, ships, drones, satellites, heavy equipment, and pharmaceuticals. In all of these industries, China has gained a significant share of the global market, and it is rapidly expanding into new sectors such as robotics, AI, quantum computing, and biotechnology [19].

Taking into account China's experience and the specifics of its development within the framework of the knowledge economy, the Republic of Belarus can learn from China's best practices and identify areas for its own development, as well as key factors that have enabled China to effectively leverage its opportunities in the transition to a knowledge-based economy through the synergy of education, science, and innovation.

Conclusion

Thus, the government's policy towards the formation of a knowledge-based economy sets the government's objectives to improve all processes that will enhance the country's overall competitiveness. The chosen vector dictates the specific behavior regarding changes in the vector of financing and production development, allowing countries to maintain leading positions in terms of key indicators and indices that characterize their level of development. Given that education, science, and innovation are the foundation of a knowledge-based economy, leading countries are increasing their investments in these areas, improving their performance in international rankings, and confirming their chosen vector of development. The Republic of Belarus is also improving its policy on the formation of a knowledge economy, taking into account the achievements of foreign experience and its own strengths.

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