UDC 339.972
IRSTI 12.81
DOI 10.37238/2960-1371.2960-138X.2025.97(1).28

[1]Ahmet Tasagil, [2]Zh.T. Tanatarova, [3]L.N. Nursultanova

[1]Yeditepe University, Istanbul, Turkey
[2]Kh.Dosmukhamedov Atyrau State University Atyrau, Kazakhstan
[3]L.N. Gumilev Eurasian National University, Astana, Kazakhstan

Email: Ahmet.tasagil@yeditepe.edu.tr, zhamiga_tanatarova@mail.ru, 2012nura@bk.ru

INNOVATIVE POTENTIAL OF CHINESE SCIENCE

Annotation. The article examines the development of science in the People's Republic of China (PRC) over the last 30 years under new conditions associated with global challenges. The current situation in international relations requires each country to take measures to accelerate innovations in science, as their development determines the competitiveness of the state. In studying China's experience in organizing science, the focus is on government measures to support scientific research and the involvement of small and medium-sized businesses in this process. The research results provide a summary of the development of innovative science in China, which has outpaced the USA, Russia, and other countries.

The aim of this study is to analyze the resources and opportunities of Chinese science in the context of current political and economic relations. The article reviews the main stages of the country's scientific development over the past 30 years, characterized by stable dynamics, political will, and extensive cooperation in the economic and scientific-humanitarian fields with various countries. China aims for global leadership in science, and therefore invests in the development of many countries.

Keywords: China; science; innovation; international relations.

Introduction

The priority areas of contemporary research include the influence of the geopolitical situation on the development of states in the context of a competitive economy, as well as the mechanisms and methods for regulating the innovative potential of science.

After the collapse of the USSR and during the formation of Central Asian countries (CA), a number of Western scholars such as Bruner H., Tillett E., and Merrill M. dedicated their research to the formation of national models of higher education and science in the CA countries, their modernization, and integration into the global space.

In 2019, Russian scholars conducted a major study in the field of strategic planning for science, based on the analysis of the current situation and its dynamics, taking into account global trends in the development of science and innovation [1].

Fan Dounan examines the stages of Chinese science, focused on high technologies. Over the last two decades, China has made significant progress in its technological development. In 2011, China ranked 29th globally in the Global Innovation Index, but by 2023, China had significantly risen in the ranking, securing the 12th position [2].

Zhang P. analyzes the results of industrial parks in China after reforms, through which China has achieved impressive success in global science [3].

Ilimkozha A.E., Raeva, in their work, analyze China's interests in our region related to the economy and science [4].

Sabigazina S., Aizhong U., in their article "Analysis of research on the modernization of higher education as an indicator of China's reform and opening policy," conducted an analysis of the modernization of higher education in China, which is the result of the reform and openness policy. The unique experience of rapid expansion of Chinese higher education over the past decade is attracting more and more attention from scholars both in China and abroad. The authors conclude that Chinese researchers propose solving educational problems by utilizing progressive experiences from domestic and foreign education while maintaining the priority of Chinese national traditions and closely linking this with addressing socio-economic, political, cultural, and even moral-ethical issues in Chinese society [5].

There are also publications on the development of science in other countries, where innovation plays an important role. The works of these and other authors form the basis of this article, with the main results presented in this publication. From a theoretical and methodological perspective, these studies have significantly expanded the relevance of science development in the global world.

Materials and Methods

The research methods included interdisciplinary and institutional approaches, the method of analysis and comparison, and other general scientific methods. During the study, an analysis of state policy in the field of science was conducted, focusing on strengthening international cooperation, expanding business contacts, improving the quality of knowledge and human capital development, and creating influential scientific centers. The research strategy used in this article was determined by the chosen scientific methods. Content analysis was employed to process and analyze statistical data. Additionally, a systems approach was used to study the development of science in the context of China's socio-economic development. Comparative analysis of statistical data on the innovative development of science, presented in various sources, was also utilized.

Discussion and Results

Over the last 30 years, international practice has developed a certain experience in applying various measures to increase innovation efficiency. For example, the Republic of Korea and Singapore introduced tax holidays for science-intensive businesses. Both developed and developing countries have prioritized the strategy of fundamental research development within their socio-economic sectors. In many countries, science is funded from the budget, and the result is a multiplicative effect of research outcomes that define long-term progress in all areas of life. Historical experience shows that funding for science everywhere tends to grow, rarely interrupted by crises. Examples include innovative developments in the USA, Canada, Iran, Israel, and other countries.

Over the last 30 years, this direction has been fully realized in China, where the rate of growth in science spending has been twice as high as GDP growth. The result of state innovation policies, substantial financial investments, and growing demands for both fundamental and applied science in China (publications in international journals, international cooperation, etc.) has been the strengthening of many scientific fields and the overall role of the country in global science. The number of articles published by Chinese scientists and their citation rate has increased.

Chinese companies are actively participating in forming the new innovative sector – the global internet economy. Its core is business, primarily companies established to operate on the Internet. In Russia, these include "Yandex," "Rambler," "Mail.ru," "Ozon," etc.; in China, it’s "Alibaba"; and in the USA, it's Google, Facebook, Amazon. By income, investment activity, capitalization, and international projects, these purely internet companies are now comparable to global energy giants such as "ExxonMobil," "PetroChina," and "Gazprom" [6].

Worldwide, strategic planning documents for science development are actively created and constantly updated. In developed countries (such as the USA, EU), the focus is primarily on forecasting the most promising scientific problems and concentrating efforts from both the state and businesses through public-private partnerships. For example, at the turn of the millennium, the USA successfully implemented the very expensive megaproject "Human Genome." Every dollar spent on this project yielded 140 times its return. The USA, as a world leader, is characterized by a strong, globally spread scientific policy, aligned with the country’s overall policy, directed toward realizing its national interests [7].

In the United Kingdom, a unified approach to public project management (including scientific research, development, and innovation) is implemented based on a specific standard that contains requirements and recommendations for the formation of development stages, including control gates, rules for project reviews and evaluations, and monitoring. Considering the political, economic, and social importance of large-scale innovation projects, the government has developed rules aimed at ensuring quality project planning, continuous monitoring of progress, and evaluating socio-economic impact. An annual report on the progress of these projects is published. The “traffic light” principle is used for evaluation: depending on the achieved indicators, projects are “colored” in different shades.

In the United States, there is an electronic system for interaction between government agencies and project performers to ensure project execution. The contract may provide direct access for the agency to the project management system of the contractor. If direct access is not specified, the contractor inputs monthly data on project results into the agency’s management system. In any case, the agency controls the situation, evaluates risks, and coordinates corrective actions with the contractor. The gates model is used in the management of research and development (R&D) projects in countries such as the USA, UK, Canada, Australia, New Zealand, Sweden, and others within the OECD. This model covers all stages, from concept formation to the completion of new technology development and the start of serial production. Before each stage begins, “gates” are established, which prevent managers from continuing the project until specialists (gatekeepers) assess the completed work [8].

Each country cares about the development of science: it allocates funds for research, strengthens material resources, and trains personnel. Today, China is confidently moving toward a leading position in the world in the field of scientific research and development. The modern Chinese Academy of Sciences (CAS) was established in 1949, shortly after the founding of the People’s Republic of China. In the following years, especially during the reforms of Deng Xiaoping, science received a new impetus for its development. A turning point in the development of science in China was the 1978 government decision, known as the “four modernizations” — industry, agriculture, science and technology, and the armed forces. The “Program of Four Modernizations” was based on the policy of openness to advanced global experiences, utilizing the best achievements in science and technology, attracting foreign capital in conjunction with the country’s own path of development. China has already formulated goals for 2050 and 2100. According to forecasts, China may become a superpower by 2050 and could become a world leader by the end of the 21st century. From 1988 to 2015, laws and government programs were adopted to rapidly implement advanced domestic technologies in production. As a result of these efforts, the number of researchers (including engineers working in R&D) increased from 522,000 to 3.8 million from 1995 to 2014, a 7.3-fold increase. In 2009, China ranked third in the world in terms of universities that entered the top 200, with 11 universities, behind only the United States and the UK. New opportunities for international scientific cooperation were opened by the "Belt and Road Initiative". In May 2017, China launched its plan for scientific and technological innovation under this initiative, focusing on scientific, technological, and humanitarian exchanges, creating joint laboratories, cooperation in scientific and theoretical parks, and technology transfer. China’s active participation in international scientific cooperation and its advancement in several scientific areas is a testament to the breakthrough of Chinese scientific thought and its dynamic entry into the leading ranks of countries in the field of fundamental scientific research [9].

China is one of the largest global investors in infrastructure development. In 2023, the “Belt and Road Initiative” celebrated its 10th anniversary. There is no unified official statistic on its development, and many different assumptions are made. However, China is actively launching projects in countries with medium and low income levels, traditionally facing infrastructure issues (e.g., Zambia, Senegal, Myanmar). These countries were not previously attractive to Western investors but are changing due to China's activities. China’s presence in several regions is seen by G7 nations as a serious challenge to their own trade and economic interests. At the G7 summit in June 2021, US President Joseph Biden announced the creation of a new international project called “Build Back Better World” (B3W), which was renamed in 2022 as the “Partnership for Global Infrastructure and Investments” (PGII). The initiative focuses on developing infrastructure projects in medium and low-income countries and implementing corresponding Western standards to attract foreign direct investment. This cooperation between the United States and its G7 partners is aimed at jointly developing standards and legislative norms for investment projects in infrastructure. However, for competitiveness, this system of standards should also involve third parties. The growing competition in infrastructure is becoming a significant addition to the US-China rivalry, involving additional actors in international relations, and potentially creating a new dividing line in trade, standards, and technology [10].

In 2023, China's R&D spending reached over 3.3 trillion yuan (around $458.5 billion), increasing by 8.1% year-on-year. This amounted to about 2.6% of China's GDP. Notably, investments in fundamental research in 2023 were 221.2 billion yuan, an increase of 9.3%. China issued 921,000 patents for inventions in 2023, up by 15.3% from the previous year. Significant achievements were made in areas such as quantum technologies, integrated circuits, artificial intelligence (AI), and biomedicine. In December 2023, China launched the world's first fourth-generation nuclear power plant, "Shidaowan," and in May, the Chinese C919 aircraft made its first commercial flight. China's R&D spending in 2024 is expected to increase by about 10%. China ranks second in the world in R&D investment, just behind the US, with US spending nearly double that of China. However, the share of government R&D investments in the US is smaller than in China. China's private sector is heavily invested in R&D, encouraged by government support. China aims to achieve leadership in key modern technologies such as biology, quantum technologies, medicine, and semiconductors. China intends to compete with Western powers in these fields and will not accept technological lag in areas it cannot purchase. The West is also pushing for economic isolation of China, especially in semiconductor production, with no agreement in sight between the two countries. Artificial intelligence is also a key area for China, as the US is willing to engage on AI regulation but is not inclined to share its advancements with China[11].

China now boasts one of the world's largest science and technology complexes, with 533 key government laboratories and 191 national engineering research centers conducting fundamental and applied research. More than 1,600 corporate technology centers are involved in the commercialization of R&D results. The country has over 130 technology parks and 1,287 business incubators. International innovation centers are being created in Beijing, Shanghai, and the Guangdong-Hong Kong-Macau Greater Bay Area for close collaboration with leading global innovation zones. As a result of these efforts, China has achieved success in important fields such as manned space flights, lunar, Mars, and deep space exploration, the Beidou satellite navigation system, manned deep-sea vehicles, high-speed railways, 5G mobile communication, and supercomputers. China's development model shows how much can be achieved with political will, long-term socio-economic programs, necessary organizational and financial resources, and a clear understanding of national strategic priorities. China's economic development is becoming more inclusive, with the benefits of growth accessible to various social groups. However, challenges remain, including imbalanced industrial and regional development, social inequality, technological dependence, environmental issues, and the national debt. The trade war with the US and the COVID-19 pandemic have also presented new challenges. Nonetheless, China's momentum and experience in overcoming difficulties suggest that the country will continue its macroeconomic transition toward a more modernized economy and a more harmonious, socially-oriented society[12].

Globalization has recently posed serious challenges to the development of science and education for countries: national independence and the search for ways to ensure sovereignty are becoming relevant once again. In this regard, China's experience in scientific development is of immense importance. The country's science and technology have undergone a historical transformation, from the creation of universities at the turn of the 19th and 20th centuries to the establishment of major research centers in the fields of physics, biology, and pharmacology. Currently, the People's Republic of China is implementing a long-term Science and Technology Development Program up to 2020, which was adopted at the National People's Congress in 2006. The country is leveraging the advantages of its current position as the "workshop of the world" on external markets, confidently reserving future functions such as laboratories, libraries, and testing grounds—of what seems to be global importance. Many of China's partners, including Russia, face a challenging task related to certain information asymmetry and inertia: there are very few technical specialists proficient in Chinese, and the vast body of knowledge generated in China can no longer be ignored. Evaluating the general problems of Chinese science, foreign analysts highlight the traditional commitment of Chinese people to their "native" workplaces. Citation indicators, especially in social sciences, are improving but still lag behind the best global standards, though other issues are gradually being resolved. The scientific and personnel foundations of recent decades are very solid. It is possible that in the near future, China will begin mass export of scientific and technical personnel. It is also worth noting that the public status and state care for scientists is very serious[13].

The early XXIst century has presented serious challenges to the economies of different countries, one of which is the need to conduct effective science and technology policies to ensure national technological sovereignty and sustainable economic development. China is a global leader in many aspects of technological development, making the study of its experience both relevant and potentially useful for the scientific and technological development of Kazakhstan.

Expenditures on research and development (R&D) in Kazakhstan have reached a record high in recent years. According to the Bureau of National Statistics (BNS) of the RK, in 2023, 172.6 billion tenge was spent on various scientific research, which is 42% more than in 2022. Compared to five years ago, this is a two-fold increase. The main drivers of science in the country are Astana and Almaty, with two-thirds of all funds allocated for R&D directed there. In monetary terms, the cost of science in the capital amounted to 36.7 billion tenge, while in the southern capital, it was 77.2 billion tenge. Among the regions, notable sums were allocated in the Mangistau (13.6 billion tenge), East Kazakhstan (8.2 billion tenge), and Karaganda (7.8 billion tenge) regions.

An interesting fact: more than half of all funds in the scientific field go towards salaries for scientists, lab technicians, engineers, designers, etc. Of the 172.6 billion tenge in 2023, 50.5% or 87.2 billion tenge was spent on this expenditure. The purchase of research equipment accounted for 5.7% of the total budget. By types of ownership, public institutions occupied the top spot in performing scientific work, receiving the largest portion of the budget. In 2023, the share of the public sector was 52.9%, which increased by 8 percentage points from the previous year. Based on the funding dynamics of state companies involved in science, they spent 68.5% more money last year: 91.2 billion tenge compared to 54.1 billion tenge in 2022. According to BNS data, expenditures on science in Kazakhstan are almost evenly divided into three major categories: natural sciences, humanities (including medicine, social sciences, agriculture), and engineering developments. It is worth noting that the most significant increase occurred in the two most important categories of R&D for Kazakhstan's economy. Funding for engineering developments and technologies amounted to 80 billion tenge (an increase of 10.6 billion tenge), while funding for natural sciences was 53.1 billion tenge (an increase of 22.9 billion tenge). Expenditures in other scientific fields also grew, though not as significantly in absolute terms[14].

28.03.2023 , the Concept for the Development of Higher Education and Science in the Republic of Kazakhstan for 2023-2029 was approved. The document, developed jointly with the scientific community in line with the head of state's instructions, ensures the annual allocation of grants, internships at leading scientific centers worldwide, inclusion in basic financing for the salaries of staff at the top 85 research institutes, and modernization of equipment at 16 scientific organizations. As of 2023, 120 projects reached the sales stage, generating over 16.4 billion tenge in total revenue, with 15 projects exported abroad.

In 2022, Kazakhstan developed the world's first "living" vaccine against COVID-19. The unique project was created by scientist Zhandos Kerimkulov with the help of Nazarbayev University. He launched a startup that helps farmers monitor their crops using data from NASA and the European Space Agency. Scientists in Kazakhstan made a groundbreaking discovery by chemically splitting one of the strongest metals—titanium. However, among the urgent problems, there is a lack of government support mechanisms for promoting research results, low salaries, housing issues, and others, leading to low scientific achievement indicators[15].

In China in 2019, there were 4.38 million people employed in research and development, of which 1.87 million were researchers, including 392 thousand people in basic research, 615 thousand people in applied research, and 3794 thousand people in development, which speaks of the relevance and importance of the development of modern science[16].

According to many scientists, investments in education and science are aimed at generating profit/income in the future; investments of this nature form the basis for the formation of a new type of capital. The growing influence of globalization and the knowledge society has meant that XXIst century skills have become essential to the success of higher education in general and universities in particular, with information and communication technologies playing a central role in their development.

How quickly and widely new technologies have entered the field of higher education and science can be judged by the example of the online educational platform Coursera. Over the past five to six years, more than 35 million students, thanks to her, received an education in one field or another. The platform has 150 partner universities around the world, including universities included in the list of top universities according to certain criterias. In addition, students are offered about 2,700 courses in 250 areas to choose from. According to research by McGraw-Hill Education regarding the latest trends in “digitalization,” more than 50% of American students believe that the most optimal classes are those that use digital technologies. More than 90% of students indicated that digital technologies (DT) allow them to better and faster learn educational material. It is also worth noting that experts consider the use of digital heating to be extremely useful when conducting research. The widespread and active use of digital technologies accelerates the development of scientific research. It should be noted that Kazakhstan is successfully forming a digital ecosystem of universities and this task was noted as one of the key areas in the state program for the development of education and science for 2020–2025 [17].

An important factor influencing a country's competitiveness is innovation potential, which is an ecosystem for stimulating and supporting innovation. This requires the following conditions: sufficient investment in R&D; the presence of high-quality research institutions that can generate the knowledge needed to create new technologies; extensive R&D collaboration between universities and industry; protection of intellectual property. The development of Kazakhstan's innovative potential is hampered by a lack of funding for R&D and innovation activities, a small share of innovative activity among companies and insufficient quality of research work.

With research and development costs soaring, Chinese authorities continue to step up their efforts. Firstly, research and industry priorities are adjusted from five-year plan to five-year plan. For example, in the current 14th five-year plan (2021–2025 with a vision until 2035), instead of nuclear technology (one of the priorities of the last five-year plan), hydrogen energy and the development of renewable energy sources are announced.

Secondly, despite the fact that the share of funds from the business sector in research and development costs in China is 76.3% (for reference: in Russia - less than 30%), the national authorities in 2022 decided to further expand the package of tax incentives for companies investing in science to the sector of high-tech small and medium-sized firms.

Third, China is going to strengthen its leadership in patenting (and double the number of patents per 10 thousand people by 2025), but at the same time continue to systematically increase the share of costs for basic research (from 6 to 8% of total research and development costs). As a result, China expects to reach 2.5% of R&D expenditures in GDP, and we are likely to see Huawei continue to catch up and overtake entire countries in terms of the scale of research activities [18].

Conclusion

As the conducted analysis shows, Chinese science in the post-reform period has received new impulses for its development in the context of a market economy. Without abandoning the Soviet "classical" academic heritage and adapting Western experience and modern foreign innovations, China is systematically having a significant impact on all sectors of the scientific field. Special attention is given to the preparation of modern, forward-looking scientific projects and the integration of the best scientific achievements into the economy. Thanks to the close connection between the prospects of Chinese society and scientific achievements, as well as their use in the interests of the state, science enjoys great respect and support in all layers of Chinese society. Today, Chinese science is increasingly gaining leadership in global scientific thought.

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Ахмет Тасағыл, Ж.Т. Таңатарова, Л.Н. Нурсултанова

ҚЫТАЙ ҒЫЛЫМЫНЫҢ ИННОВАЦИЯЛЫҚ ПОЦЕНЦИАЛІ

Аңдатпа. Мақалада Қытай Халық Республикасы(ҚХР) ғылымының соңғы 30 жылда жаһандық әлемдегі сын-қатерлерге байланысты жаңа жағдайларда дамуын қарастырады. Қазіргі халықаралық қатынастардың жағдайы әр мемлекеттен ғылымдағы жаңалықтарды жеделдету үшін шаралар қабылдауды талап етеді, өйткені мемлекеттің бәсекеге қабілеттілігі олардың дамуына байланысты. Қытайдың ғылымды ұйымдастыру тәжірибесін зерделеу кезінде ғылыми зерттеулерді қолдау, осы процеске шағын және орта бизнесті тарту бойынша Мемлекеттік шаралар өзектілікке ие болады. Зерттеу нәтижелері АҚШ, Ресей және басқа елдерден озып келе жатқан ҚХР инновациялық ғылымының дамуы бойынша жалпылама нәтижелерді қамтиды. Бұл зерттеудің мақсаты-қазіргі саяси-экономикалық қатынастар жағдайындағы Қытай ғылымының ресурстары мен мүмкіндіктерін талдау. Әр түрлі елдермен экономикалық және ғылыми-гуманитарлық салалардағы тұрақты динамикамен, саяси ерік-жігермен, ауқымды ынтымақтастықпен сипатталатын 30 жыл ішінде ел ғылымының дамуының негізгі кезеңдері қарастырылды. Қытай ғылымда жаһандық көшбасшылыққа ұмтылады, сондықтан көптеген елдердің дамуына инвестиция салады.

Кілт сөздер: Қытай; ғылым; инновация; халықаралық қатынастар.

Ахмет Тасагыл, Ж. Т. Танатарова, Л. Н. Нурсултанова

ИННОВАЦИОННЫЙ ПОТЕНЦИАЛ КИТАЙСКОЙ НАУКИ

Аннотация. Статья рассматривает развитие науки Китайской Народной Республики (КНР) в последние 30лет в новых условиях, связанных с вызовами в глобальном мире. Ситуация современных международных отношений требует от каждого государства принимать меры по ускорению новаций в науке, поскольку от их развития зависит конкурентоспособность государства. При изучении опыта Китая по организации науки актуальность приобретают государственные меры по поддержке научных исследований, вовлечения в этот процесс малого и среднего бизнеса. Результаты исследования содержат обобщающие результаты по

развитию инновационной науки КНР, которая опережает США, Россию и другие страны.

Целью данного исследования выступает анализ ресурсов и возможностей китайской науки в условиях современных политико-экономических отношений. Рассмотрены основные этапы развития науки страны за 30лет, которые характеризуются устойчивой динамикой, политической волей, обширным сотрудничеством в экономических и научно-гуманитарных сферах с разными странами. Китай стремится к глобальному лидерству в науке, поэтому вкладывает инвестиции и в развитие многих стран.

Ключевые слова: Китай; наука; инновации; международные отношения.