TECHNOLOGICAL PROGRESS: TOWARDS A THEORETICAL PERSPECTIVE

Irene MALGINA
PhD, Associate Professor,
Academy of Public Administration under the
President of the Republic of Belarus, Belarus
E-mail: irina_malgina@list.ru
ORCID: 0000-0002-7516-8911

Abstract: *Technological progress is a primary engine of economic growth, yet its acceleration carries costs – technological unemployment, widening inequality, capital obsolescence, and rising socio-economic and cybersecurity risks – that may offset its benefits. This paper asks whether the negative consequences of scientific and technological progress outweigh the positive ones, and how a sanctioned economy such as Belarus pursues technological sovereignty under these conditions. The study combines a qualitative analysis of the theoretical literature with a comparative review of national models of technological development in China, the European Union, the United States, Africa, and Latin America, drawing on data from the National Statistical Committee of the Republic of Belarus and the State Committee on Science and Technology. The analysis identifies the main channels through which technological progress affects growth and maps the dominant characteristics and negative effects of progress across regions. For Belarus, the science intensity of GDP rose to 0.59% by the end of 2024, the number of organisations performing research and development reached 463, and the innovation infrastructure expanded to 16 science and technology parks hosting 274 residents. The findings suggest that Belarus has not yet encountered the adverse effects of technological progress; rather, the isolation imposed by sanctions appears to accelerate its drive toward technological sovereignty. The paper argues that activating the country's innovation, start-up, and entrepreneurial ecosystems is the decisive condition for sustaining this trajectory.*

Keywords: *technological progress, negative impact, positive impact, sanctions.*

Classification JEL: *O10, O30, O38.*

UDC: *330.341.1* ***DOI:*** *https://doi.org/10.53486/ser2026.42*

1. Introduction

Scientific and technological progress is one of the main sources of economic growth and development. Its positive impact is measured by the development of artificial intelligence and big data, neural networks, biotechnology and medicine, space technology, and other areas. However, scientific and technological progress also has negative aspects, including job losses, increased inequality, environmental pollution, the side effects of green energy, technology dependence, cybersecurity, and others. All of this has led to the hypothesis that the negative consequences likely outweigh the positive impact of scientific and technological progress. It is also worth considering the experience of Belarus as a country on the path to scientific and technological progress, yet living under various sanctions.

2. Literature Review

Gichiev (2013), analyzing theoretical aspects, identifies two periods in the modern stage of economic growth research: models that explain the sources of growth using external effects of learning by doing and human capital, thereby motivating the absence of diminishing marginal productivity; the second series of new wave models focused on explaining the origin of technological progress and a detailed development of the structure of the emergence and implementation of innovations.

Gaipov et al. (2024) argue that innovation plays a central role in modern economic development, contributing to productivity growth and the creation of new opportunities. It influences all aspects of the economy, facilitating its dynamic development.

Technological progress plays a vital role in economic growth and development. Belyakov and Kochemaskin (2014) note that at the current stage of development, the direct influence of scientific and technological progress is becoming one of the key factors in economic growth and improving the well-being of the population in most industrialized countries.

In this regard, the study by Galor and Tsiddon (1997) is important. They state that in periods of major technological inventions, a decline in the relative importance of initial conditions raises inequality, enhances mobility, and generates a larger concentration of high-ability individuals in technologically advanced sectors, stimulating future technological progress and growth. However, once technologies become more accessible, mobility is diminished and inequality decreases but becomes more persistent. The reduction in the concentration of ability in technologically advanced sectors diminishes the likelihood of technological break-throughs and slows future growth. User friendliness, therefore, becomes unfriendly to future economic growth.

Despite the positive impact of scientific and technological progress on economic growth and development, there are also negative aspects. As Berdieva et al. (2024) write, technological progress is an important factor in economic growth. This leads to increased productivity, which, in turn, leads to improved economic performance. However, technological advances can also lead to demand-pull inflation, which can limit economic growth.

Ayres (1996) notes that increasing welfare is due primarily to science and technology, and only secondarily to economic growth. Scientific and technological progress generated economic growth, not vice versa. In its present form, economic growth can hinder technological progress (through increasing returns to scale reducing the rate of innovation). But current technological progress can negatively impact economic growth, and especially in the field of information technology.

3. Methodology

This study utilizes both qualitative and quantitative research methods to enhance readers' understanding of issues related to scientific and technological progress. Specifically, it analyzes the views of various scholars on the role of scientific and technological progress in economic growth and development. Qualitative analysis is used to identify the positive and negative aspects of scientific and technological progress, thereby providing a theoretical basis for further research. The analysis of scientific and technological progress is based on data from the National Statistical Committee of the Republic of Belarus, the State Committee on Science and Technology, and other online sources.

4. Results and Discussion

Our study draws on the work of Égert (2026), who builds on the innovation-led growth research of the 2025 Nobel laureates in economics – Joel Mokyr, Philippe Aghion, and Peter

Howitt – and on the broader evolution of modern growth theory and empirical evidence. Building on these concepts, Égert interprets the widespread slowdown in productivity growth observed in advanced OECD countries since the mid-2000s and argues that the key explanatory factors include a decline in creative destruction, a slowdown in the diffusion of advanced technologies, a decline in business dynamism, and the negative impact of policy.
From our point of view, key aspects of the negative impact of technological progress:

- Technological unemployment: The replacement of humans by machines and artificial intelligence (AI) is leading to the disappearance of a number of professions. In the short term, this creates an imbalance in the labor market, as workers are unable to retrain quickly.
- Growth of inequality: Technology increases the demand for highly skilled workers, raising their incomes, while the wages of low-skilled workers stagnate or decline, exacerbating social inequality.
- Structural shifts and obsolescence: Rapid technological change makes previously acquired equipment (capital) unprofitable. This forces companies to write off old assets and incur the costs of implementing new ones, which can slow growth in certain sectors.
- Socioeconomic risks: Technological development requires significant expenditures on training and retraining of personnel and also carries risks related to AI ethics and data protection.

Based on the analysis of various opinions of scientists, the Classification of Regional Economic Stability Factors was identified: dominant technology and techniques in society; state economic policy; Operational; Market; Investment; Other.
Key features of endogenous scientific and technological progress can also be highlighted:

- Learning-by-doing: Productivity growth occurs automatically with increasing production scale.
- Investment in knowledge: Technological progress is generated by the activities of scientific schools, personnel development, and R&D expenditures.
- The role of government: Government policy influences the rate of endogenous scientific and technological progress through support for education, science, and the creation of innovation infrastructure.

After conducting an empirical study of technological progress and economic growth based on statistical data from 1999 to 2013 in Anhui Province, Ding (2015) states that firstly, technological progress and economic growth are a long-term stable equilibrium relationship, with each increase of 1% of technological progress increasing economic growth by about 0.6%; secondly, technological progress and economic growth are the causal relationship between granger. Thirdly, when the impact of technological progress comes into being, it can bring more long-term, positive influence to economic growth.

The interaction between digital platforms and technological innovation on economic growth deserves special attention. Considering the case of China based on panel data from 30 Chinese provinces for the period from 2013 to 2023, Chinese scholars conclude that unobserved heterogeneity and a solution to the heteroscedasticity problem are absent. The results show that digital platforms have a statistically significant and positive impact on economic growth: a 1% increase in digital platform activity is associated with 0.0344% economic growth. Moreover, the interaction between digital platforms and technological innovation further enhances this effect, contributing to an additional 0.0378% economic growth. This finding highlights the relationship between digital platforms and technological innovation, emphasizing the importance of integrated policy frameworks that promote both digital development and technological progress to support economic growth in China (Li et al., 2026).

An important aspect of scientific and technological progress is innovation in the military-industrial complex. A study by Zhu et al. (2024) examines the impact of military-industrial base financing efficiency on non-technological innovation, based on Chinese data. Noting that innovation in the military-industrial base requires not only technological progress but also scientific organization and management, as well as a sound business model, the authors establish that military-industrial base financing efficiency has a significant positive impact on organizational and market innovation, which is especially noticeable in state-owned enterprises and military companies. The mechanism of influence lies primarily in improving information symmetry and reducing agency costs.

By analyzing the structure of government expenditure, technological progress and economic growth, Liu et al. (2023), based on the construction and estimation of the New Keynesian endogenous technological progress model and using the time series data of Chinese macroeconomics from 1996 to 2019, conclude that compared with the traditional dynamic stochastic general equilibrium (DSGE) model, the endogenous process of technological progress enhances the impact of government consumption shock and traditional government investment shock on the macroeconomy, which leads to stronger fluctuations in the business cycle.

The analysis made it possible to identify the main features of scientific and technological progress in various countries and regions (Table 1).

Table 1. Main characteristics of scientific and technological progress in different countries and regions

China	Europe	USA	Africa	Latin America
Main characteristics of scientific and technological progress in different countries and regions				
A successful model of transformation from a backward economy to a global technological leader through strong government planning, massive investments in R&D, and the development of quantum technologies, artificial intelligence, space exploration, and electric vehicles. Key factors include talent development, commercialization of innovations, and the goal of becoming a scientific superpower.	based on the integration of science and industry, the active role of the state in funding innovation, creating technology platforms, and supporting small and medium-sized enterprises. Key elements include research commercialization, venture capital financing, and a focus on sustainable development, ensuring high competitiveness.	is based on a powerful synergy between government, private industry, and universities, ensuring the US leadership in AI, aerospace, and bioengineering. Key factors include high R&D spending (41% of global high-tech production), a flexible venture capital system, effective technology transfer, and intellectual property protection.	a unique blend of ancient innovations and rapid modern development focused on mobile technologies, fintech, and green energy. The continent is rapidly transforming into a startup hub, overcoming infrastructural limitations through digitalization, with South Africa, Egypt, Nigeria, and Ghana emerging as key players.	characterized by attempts to transition from a raw materials-based model to an innovative one through economic integration, the development of paradiplomacy, and the creation of regional scientific and technological relations. Key focuses include economic diversification (Chile), support for innovation policy, and the adaptation of international technologies.
The main components of the experience				
• Strategic Planning and Financing: The state sets strict goals, backed by extensive funding. Priority is given to industrial development and achieving technological sovereignty. • Development of Breakthrough Technologies: China has become a leader in quantum cryptography, communications, computing, artificial intelligence (AI), and electric vehicle production.	Integration of Science and Technology Policy: The EU is creating a common space where technology policy is aligned with political objectives, facilitating the rapid adoption of innovation. Technology Platforms: National and pan-European platforms bring together business, science, and government to define research priorities. Venture Capital: The government acts as a catalyst, reducing risks for private	High R&D spending: The United States consistently ranks among the world's leaders in research and development spending. Science-Business Collaboration: Universities such as MIT, Stanford, and Berkeley actively commercialize scientific research by creating startups. Government Role: Public funding is often directed toward fundamental research and strategic sectors (defense, space,	Leapfrogging: Africa often skips intermediate stages of development, adopting cutting-edge technologies immediately. A prime example is the M-Pesa mobile payment system in Kenya, which has provided financial access to the unbanked population. Startup Continent: Nigeria, Ghana, and Kenya are seeing a growing number of innovative companies in fintech, agritech, and healthcare.	• Integration Processes: The Latin American Integration Association (LAI) brings together 12 countries to create a common market and collaborate on technology. • Innovation Policy: Countries in the region, such as Brazil and Chile, are actively implementing measures to support innovation and industrial modernization. • Economic Diversification: Chile offers a successful example, where mining, agriculture, and services have

• Integration of Science and Business: An effective model for commercializing innovations, whereby research results are quickly implemented into production. • Attracting Talent: Actively working to bring back specialists from abroad and create conditions for young scientists. • International Cooperation: China is actively leveraging the experience of international scientific and technological cooperation to accelerate its own development.	investors and stimulating the development of start-ups. The Role of SMEs: Small and medium-sized enterprises (SMEs) play a crucial role in the innovation economy, ensuring flexibility and the rapid adoption of new technologies. Sustainability and Security: Particular attention is paid to green technologies and managing the social impacts of automation.	AI), mitigating risks for private investors. Venture Capital: A well-developed venture capital ecosystem (Silicon Valley) enables the rapid scaling of promising technologies. Flexible Manufacturing: Focus on high-tech, diversified, and small-scale production that adapts to market demands. Human Capital: Attracting top scientific talent from around the world through a high-quality education system and immigration policies.	Scientific and Educational Potential: Despite challenges, African countries (especially South Africa and Egypt) are building their research capacity, participating in global technological transitions. Agricultural Innovation: The introduction of improved crop varieties (for example, in Ghana) significantly increases farm productivity.	become drivers of technological development. • International Cooperation: Developing scientific and technological relations with other regions (for example, with Russia) is an important element in enhancing competitiveness.
Key achievements (key areas of leadership)				
• Advances in quantum radar, metrology, and navigation. • Launch of the Shenzhou spacecraft. • Leadership in the production of eco-friendly vehicles.	Green Technologies and Energy: The EU is a global leader in developing technologies to combat climate change, develop renewable energy sources (RES), hydrogen energy, and clean manufacturing. Digitalization and AI: Active development of quantum technologies, cybersecurity, artificial intelligence (AI), semiconductors, and digital infrastructure, aimed at ensuring technological sovereignty. Biotechnology and Life Sciences: High-level research in	Artificial Intelligence and Big Data: Leadership in neural network development. Biotechnology and Medicine: Development of advanced prosthetics and treatments. Space Technologies: Private companies (SpaceX, Blue Origin) are changing the industry.	Digital Economy and Fintech: Leadership in mobile payments (M-Pesa), mobile app development for services, e-commerce development, and innovative banking solutions (especially in Kenya and Nigeria). Agritech (AgTech): Innovation for sustainable agriculture, precision farming, drought management, and crop yield improvement. Green Energy: Active development of renewable energy sources (solar, wind,	Aerospace: Brazil (Embraer) is a world leader in civil aircraft production. Nuclear Energy and Nuclear Technologies: Argentina and Brazil are developing their own nuclear power cycle technologies, designing and constructing nuclear power plants. Agricultural Biotechnology: Highly developed plant genetics, developing resistant varieties (soybeans, corn), and precision farming technologies. Mining and Metallurgy: Implementation of robotic

	genetics, medical biotechnology, pharmaceuticals, and the bioeconomy. Aerospace: Development of advanced space technologies, satellite systems, and aerospace research. Materials Science and New Materials: Creation of composite materials, nanotechnology, and advanced materials for industry. Industry 4.0: Implementation of comprehensive automation, digitalization of production processes, and robotics.		geothermal) to overcome energy shortages. Biotechnology and Medicine: Development of local vaccine production (e.g., in South Africa and Senegal), use of digital medicine (telemedicine), and diagnostic technologies. Space Technologies: Countries (Egypt, South Africa, and Nigeria) are developing and launching their own satellites for resource monitoring, communications, and geodesy. Innovation Hubs: Growth of technology clusters supporting startups in AI, big data, and IoT, enabling high levels of innovation activity exceeding	systems and smart technologies for copper (Chile) and oil (Brazil, Mexico) mining. Renewable Energy: Leadership in the use of hydropower and the introduction of solar and wind energy technologies. IT and Fintech: Development of digital platforms, fintech, and startups (especially in Brazil and Mexico).

***Source**: own scientific research*

The analysis allowed us to identify the main negative elements of scientific and technological progress in the analyzed regions and countries (Table 2, 3).

Table 2. The main negative consequences of scientific and technological progress in China, Europe and the USA

China	Europe	USA
Environmental crisis Technological dependence Socioeconomic problems Digital limitations Economic imbalance Intellectual property issues Demographic challenges	• Socioeconomic issues: Job loss Growing inequality Decreased competitiveness • Environmental risks: Pollution Side effects of green energy • Technological and personal risks: Technology dependence Cybersecurity Deteriorating health	• Socioeconomic issues: Automation and unemployment Digital addiction Erosion of privacy • Cultural and psychological changes: «Virtualization» of life Depersonalization • Technological and scientific risks: Cybersecurity Slowing scientific discovery •Environmental consequences: Pollution

Source: *own scientific research*

Table 3. The main negative consequences of scientific and technological progress in Africa and Latin America

Africa	Latin America
Digital Divide and High Costs Environmental Risks Economic Dependency Social Instability Infrastructure Inadequacy	Technological Dependency and Brain Drain Environmental Issues Socioeconomic Inequality Economic Vulnerability

Source: *own scientific research*

Belyakov and Kochemaskin (2014) identify the following key areas of scientific and technological development: the creation and use of advanced technologies; technological modernization of economic sectors; development of high-tech production (goods and services); formation and development of technological infrastructure; development of applied technological science; increasing the level of technological competencies of personnel.

According to various scholars, the channels through which scientific and technological progress influences economic growth include the following areas: technology diffusion (foreign direct investment, imports, international trade; investments, imports, international trade); market competition (technological frontier, incentives for innovation, imitation, frontier, incentives for innovation, imitation); credit constraints (human capital, investments); human capital (innovations, imitation).

We agree with Brown and Ulijn (2004) that any technological progress, innovation or economic growth created by an organization depends on how the culture and environment of this organization contribute to or hinder these processes.

The analysis revealed that the science intensity of Belarus's GDP by the end of 2024 increased and amounted to 0.59% (Fig. 1).

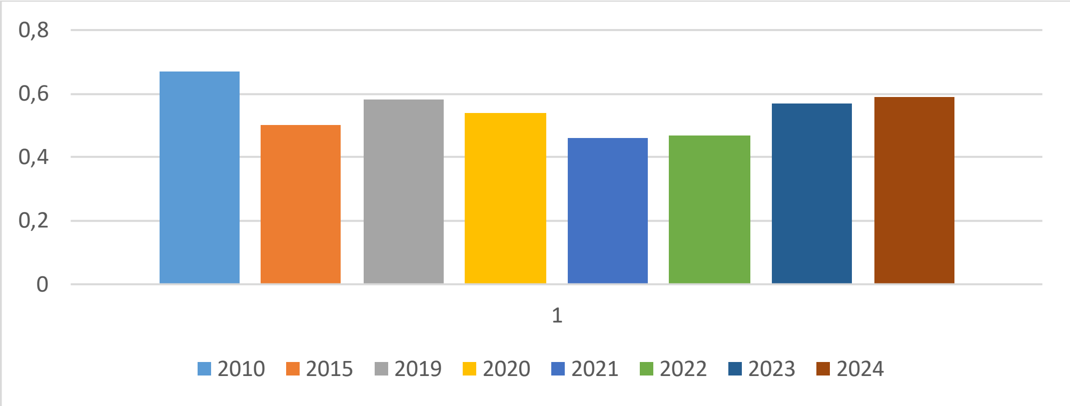

Figure 1. Science intensity of Belarus's GDP in the period 2010-2024

Source: *compiled by the author based on data from the National Statistical Committee of the Republic of Belarus*

Based on the view of Liu et al. (2023) that public investment in science and technology has a positive external impact on firms' research and development activities and the application of innovative achievements, and that in the long term it can contribute to more sustainable economic growth than government consumption and traditional investment, we analyze the types of R&D expenditures by sector.

An analysis of the types of R&D expenditures by sector revealed that, by the end of 2024, the commercial organizations (entrepreneurial sector) sector is the leader (Figure 2).

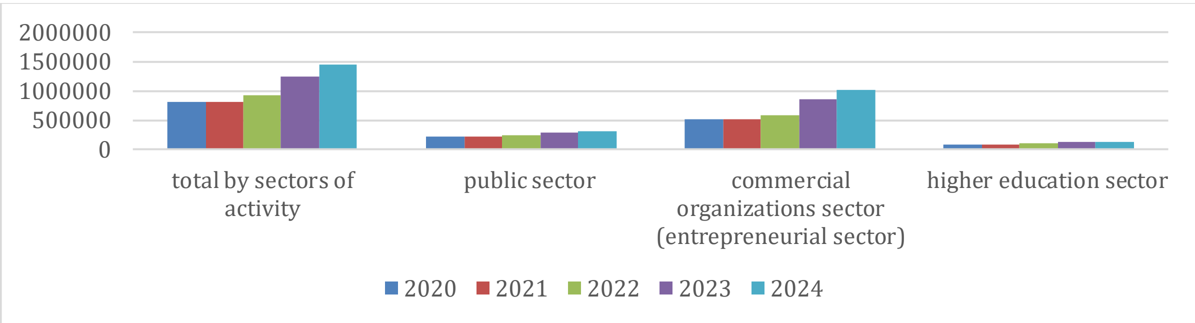

Figure 2. Domestic expenditure on scientific research and development in the Republic of Belarus in the period 2020–2024, in thousands of rubles

Source: *compiled by the author based on data from the National Statistical Committee of the Republic of Belarus*

The analysis showed that the number of organizations carrying out scientific research and development in the Republic of Belarus increased and amounted to 463 units by the end of 2024 (Fig. 3).

The analysis showed that the largest number of organizations that carried out scientific research and development in the regions of the Republic of Belarus in the period 2020-2024 are in the commercial sector (entrepreneurial sector).

In terms of the activities of intellectual property protection institutions, the study by Nazeer and Rasiah (2024) is valuable in analyzing the role of institutional quality in Pakistan in technology transfer, technological progress, and economic growth. Examining the role of institutions in Pakistan's efforts to stimulate technological progress, specifically analyzing the evolution of institutional quality, technology transfer through technical cooperation grants, technological progress, and economic growth, the authors conclude that policymakers in Pakistan need to focus on developing the skills and competencies necessary for obtaining patents and fostering an entrepreneurial mindset, emphasizing the critical role of strong institutions in this process.

Figure 3. Number of organizations carrying out scientific research and development in the Republic of Belarus in the period 2020–2024, units

Source: *compiled by the author based on data from the National Statistical Committee of the Republic of Belarus*

In the Republic of Belarus, the National Intellectual Property Center of the Republic of Belarus operates, the activities of which are based on the Strategy of the Republic of Belarus in the Sphere of Intellectual Property until 2030. According to the Strategy, the main goals of state intellectual property policy are:

- in the medium term – building the potential of intellectual property as a key element of the national innovation system, enhancing its role in the development of high-tech and knowledge-intensive sectors of the national economy, the socio-cultural sphere, investment, and export activities;
- in the long term – comprehensively integrating the national intellectual property system into the state's socio-economic policy and enhancing the competitiveness of the national economy based on knowledge and innovation.

Considering the role of science and technology parks in scientific and technological progress, it is necessary to dwell on the study by Jiang and Mei (2016). The authors conduct an empirical study of the influence of the social capital of a science and technology intermediary on knowledge transfer using the example of the Science and Technology Park of Nanjing University. In examining the mechanism by which the social capital of a science and technology intermediary influences knowledge transfer, the authors conclude that network ties in the structural dimension of social capital of a science and technology intermediary are relatively close and act as the "center" of social capital connections within the network. The network is denser and more connected, creating a favorable environment for knowledge transfer. Network stability is highest in universities, better in research institutes and incubators, and lowest in enterprises. A study of the relationship between the social capital of a science and technology intermediary and knowledge transfer shows that social capital associated with the government can positively contribute to the opportunities and motivation for knowledge transfer, but has a weaker impact on the potential for knowledge transfer. Social capital associated with the source of knowledge and corporations has a positive impact.

Science and technology parks (technoparks) play a key role in progress, serving as a link between science and industry. They accelerate the commercialization of innovations by providing researchers with the infrastructure for creating prototypes. Technology parks bring together startups, universities, and industrial enterprises, stimulating the growth of knowledge-intensive industries and the development of regional economies.

The key aspects of technology parks' role in scientific and technological progress can be summarized as follows:

- *Commercialization of scientific research:* Transforming the results of research and development (R&D) into finished commercial products.
- *Creation of innovative infrastructure*: Providing residents with access to modern laboratories, production facilities, offices, and shared-use centers.
- *Fostering startups:* Supporting small innovative enterprises in the early stages (including consulting, mentoring, and assistance in attracting investment).
- *Integrating science and the real sector:* Ensuring close collaboration between universities, research institutes, and manufacturing companies.
- *Economic growth and job creation:* Developing high-tech industries, which leads to increased competitiveness of the regional and national economies.

It should be noted that Belarus has 23 innovation infrastructure entities (16 science and technology parks and 5 technology transfer centers). While there was only one technology park in 2009, their number has steadily increased (Figure 4).

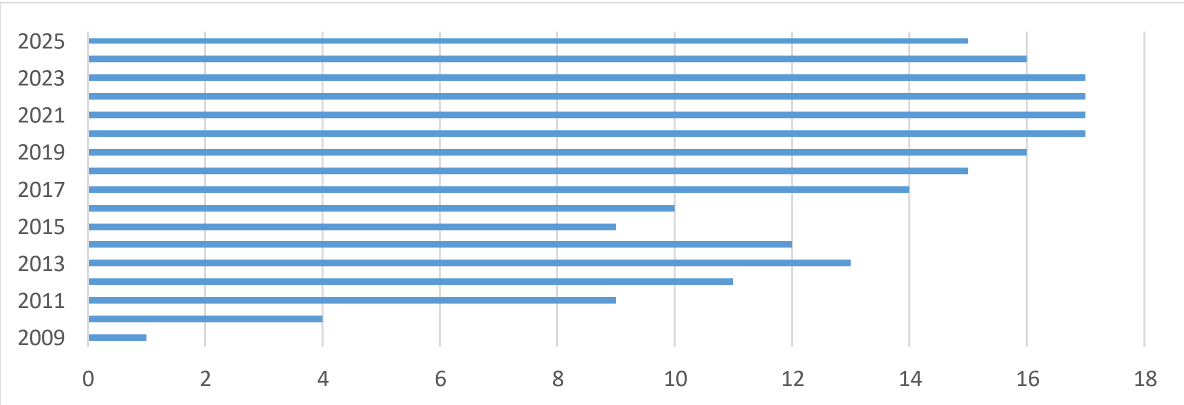

Figure 4. Development dynamics of science and technology parks in the Republic of Belarus in 2009-2025, units.

Source: *compiled by the author based on data from the Belarusian Institute of System Analysis and Information Support for Science and Technology*

The number of science and technology park residents is also steadily increasing. By the end of 2024, the number of residents reached 274, while the number of resident employees decreased to 928 (Figs. 5-6).

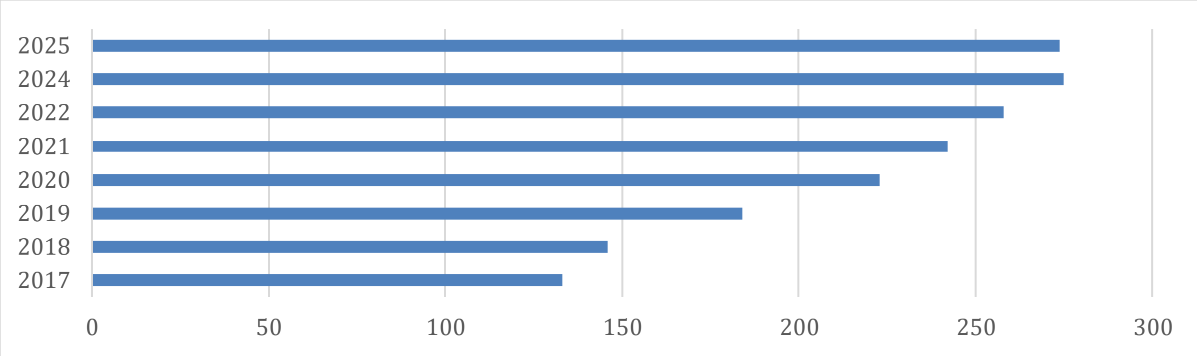

Figure 5. Number of residents of science and technology parks of the Republic of Belarus in the period 2017-2025, units

Source: *compiled by the author based on data from the Belarusian Institute of System Analysis and Information Support for Science and Technology*

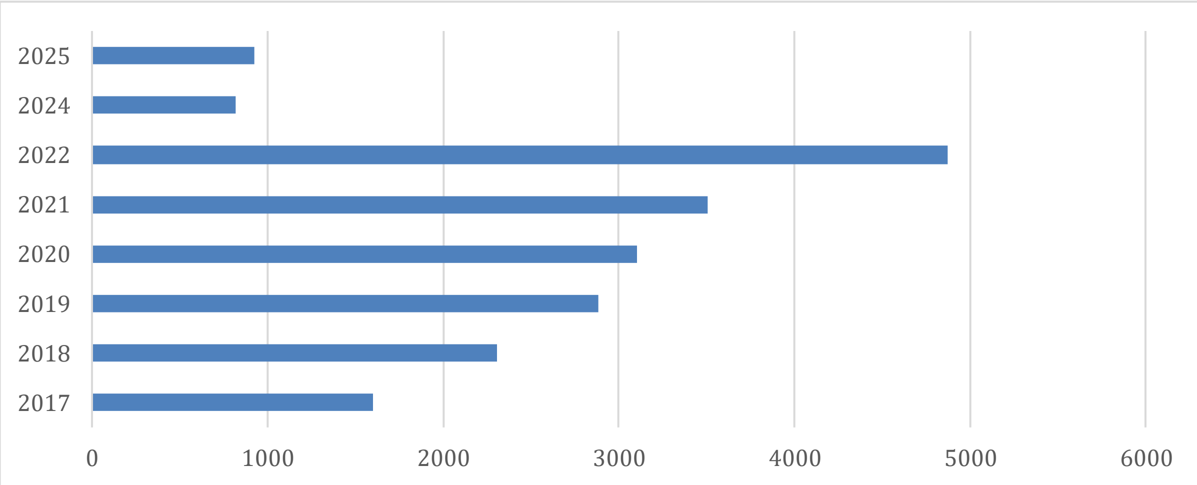

Figure 6. Number of employees of residents of science and technology parks of the Republic of Belarus in the period 2017–2025, units

Source: *compiled by the author based on data from the Belarusian Institute of System Analysis and Information Support for Science and Technology*

Various competitions and startup events are held annually in the country, including «100 Ideas for Belarus», «Greatstartup» startup competition (Minsk City Technopark LLC, etc.), the «ENCOBI» business idea competition (InCata Scientific and Technological Park LLC, etc.), hackathons, and competitions such as «Startup Bootcamp BSU», «Minskaya Smena»,and other events. A Startup Center was established within the Secretariat of the Supervisory Board of the High-Tech Park (HTP) (2024), which has signed agreements with virtually all universities for startup development as part of the «University 3.0» concept in Belarus.

In Belarus, loans for innovation and modernization are provided by the Development Bank, Belarusbank, and other banks, offering rates of approximately 0.5 times the National Bank's refinancing rate. Preferential financing for up to 7-15 years is available for small and medium-sized businesses (SMEs) and investment projects, including the acquisition of equipment, technology, and the creation of high-tech production facilities.

Main sources of innovation financing:

1) Development Bank of the Republic of Belarus (DBRB): Programs for SMEs offering financing for the implementation of innovations, the acquisition of equipment, and the creation of new production facilities.
2) Belarusbank – «Micro-Business Innovations» is a specialized loan product designed to support small businesses, including technology park residents. The loan is issued for a term of up to 7 years in an amount of up to 15,000 basic units to finance investment projects, the creation of non-current assets, and the acquisition of equipment.

Main terms of the «Micro-Business Innovations» product:

- Purpose: creation of non-current assets, acquisition of equipment, intangible assets, and increasing working capital as part of an investment project.
- Target audience: technology park residents, small businesses.
- Loan amount: up to 15,000 basic units.
- Loan term: up to 7 years.
- Collateral: pledge of the acquired property, as well as a surety from individuals (usually up to 50% of the amount).
- Benefits: Possibility of deferring principal repayment.

3) Industry funds and the Belarusian Innovation Fund: Support for scientific and technical projects, modernization of production facilities.

The Belarusian Innovation Fund (BelInfond) provides financial support for the development of scientific and technical, high-tech, and venture projects, ensuring their commercialization. The fund's main products are targeted loans, commercialization grants, financing of research and development work, and expert evaluation of innovative ideas.

The BelInfond's main areas of support:

- *Financing of innovative projects:* Providing repayable funds for the creation of new production facilities, the implementation of new technologies, and the production of high-tech products. Venture Financing: Investing in risky projects that are in the early stages but have high growth potential.
- *Commercialization of Scientific and Technical Developments:* Providing grants for the implementation of research results in the real economy.
- *«Strong Regions» Product:* A financial instrument aimed at supporting regional investment initiatives and developing local infrastructure.
- *Expertise and Support:* Belinfond acts as a government customer, drafting tripartite agreements and overseeing the use of funds and project implementation.

The fund works with projects within the framework of state, industry, and regional scientific and technical programs.

4) Partner Banks (Priorbank, Belgazprombank): Specialized loan products for modernization and the purchase of fixed assets.

For example, Belgazprombank actively supports innovative projects, offering loans to businesses focused on import substitution, high technology, and green initiatives. Financing is available in Belarusian rubles (from 6.38% under partnership terms) and foreign currency, with long-term lending options (up to 5 years).

Key areas of innovative loans:

- Technology and Innovation: Support for companies developing new technologies and import-substituting products.
- Green Loans: Financing energy efficiency and sustainable energy projects with reduced interest rates.
- Investment Loans: Financing for equipment acquisition, production modernization, and the implementation of new solutions.
- Financing through the Development Bank: Special programs for small and medium-sized businesses, including those for innovation, with rates starting from 6.38% BYN.

Priorbank offers specialized loans for innovative businesses, including investment programs of up to 500,000 BYN (up to 60 months) and support programs from the Development Bank. Rates for these special programs range from 6.25% to 10.5%. Financing options are also available for modernization and the purchase of eco-friendly products.

Key credit products for innovation and development:

- Investment loans: Designed for modernization and development. Amount: up to 500,000 BYN, covering up to 80% of the project cost, term: up to 60 months, often without the need for providing a feasibility study.
- Special programs of the Development Bank: Support for manufacturing, environmental projects, and startups. Rates range from 6.25% to 10.75%, terms of up to 60 months. Financing for ongoing operations: Up to 500,000 BYN for up to 18 months (rate of ~12.91%) for working capital, which can be used for innovation.
- Green loans: Programs for the purchase of environmentally friendly goods and equipment.

An analysis of loan products revealed the Development Bank of the Republic of Belarus, which offers the «Technological Self-Sufficiency» loan (Tab. 4).

When examining the role of the state in scientific and technological progress, Xin's (2024) article on institutional openness, technological progress, and national economic growth is worth mentioning. Using data from the Global Innovation Index for 2013–2022, the author examines the impact of China's «Special Plan for Cooperation in Scientific and Technological Innovation within the Framework of the Belt and Road Initiative» (SPCI) on the per capita gross domestic product (GDP) of countries along the route. The results show that the SPCI policy increases GDP by continuously stimulating technological progress. For countries with low human capital and low technological capabilities, the policy's impact is more pronounced.

Table 4. Key Focus Areas of the Technological Self-Sufficiency Credit Program of the Development Bank of the Republic of Belarus

Financing Options	Terms	Requirements for Investment Projects Eligible for Lending
Import substitution, localization and local raw materials	Loan currency – Belarusian ruble; loan term – the payback period of the investment project, but no more than 15 years; loan amount – no more than 100 million rubles; interest rate – no more than 7 percent per annum from the date of the loan agreement until December 31 of the sixth year following the year of the loan agreement; no more than the refinancing rate increased by 3 percentage points – in subsequent years.	a) Import substitution – production of high-tech import-substituting products for final consumption b) Localization – increasing the level of localization of in-house production and/or production of products for the business entity to which products are shipped under the project, and/or production of products corresponding to the codes of the General State Classifier of the Republic of Belarus OKRB 007–2012 «Classifier of Products by Type of Economic Activity», specified in the Appendix to Resolution No. 80 of the Government of the Republic of Belarus dated February 17, 2022 c) Local raw materials and materials – production of furniture, finished products made from flax with in-depth processing of domestic raw materials and materials (own and purchased – wood, fiberboard, flax) and other types of products from local raw materials as instructed by the Government
Promising industrial directions	Loan currency – Belarusian ruble; loan term – the payback period of the investment project, but no more than 15 years; loan amount – no more than 100 million rubles (for items "a" and "b" of column 3); loan amount – no more than 200 million rubles (for item "c" of column 3); interest rate – no more than 6 percent per annum from the date of execution of the loan agreement until December 31 of the sixth year following the year of execution of the loan agreement; no more than the refinancing rate increased by 3 percentage points – in subsequent years.	a) organizing the production or implementation of robotic systems (industrial robots); b) organizing the production of unmanned systems (air and ground); c) organizing the production of biotechnology-based products)
Industrial mortgage projects	Loan currency – Belarusian ruble; loan term – the payback period of the investment project, but no more than 15 years; interest rate – no more than 7 percent per annum from the date of the loan agreement until December 31 of the sixth year following the year of the loan agreement; no more than the refinancing rate increased by 3 percentage points – in subsequent years.	These projects provide for the construction of industrial buildings for subsequent lease, including with the right of subsequent purchase, to small and medium-sized businesses. are implemented by: – organizations authorized by local authorities; – business entities that are residents of free (special) economic zones; – organizations acting as management companies (development companies) of industrial parks and special economic zones; – technology parks.

Source: *compiled by the author based on data from the Development Bank of the Republic of Belarus*

State concepts of scientific and technological progress (STP) aim to improve economic efficiency through innovation, automation, and the creation of knowledge-intensive industries. Key tools include the Comprehensive Scientific and Technical Progress Forecast (CSTP), state programs for innovative development, and the identification of priority areas (AI, biotechnology, new materials) to achieve technological sovereignty.

Key aspects of the state concepts of the scientific and technical progress of Belarus:

- *Comprehensive Forecast (CSTP):* Developed for the long term (e.g., until 2040–2045) to assess global trends and identify promising technologies.
- *Priority areas:* The State Committee on Science and Technology (SCST) compiles a list of key industries that contribute the most to GDP.
- *Implementation:* Conducted through state scientific and technical programs (SSTP) and full-cycle innovation projects (R&D - OK(T)R - production).
- *Goals:* Technological modernization, growth in high-tech exports, and ensuring national security.

Main forms of state-stimulated scientific and technical progress:

- Evolutionary: Modernization of current production based on existing scientific knowledge.
- Revolutionary: Implementation of fundamentally new, breakthrough technologies (AI, nuclear energy, robotics).

The state stimulates scientific and technological progress (STP) through support for technological innovation, the development of fundamental science, and the digitalization and automation of production. The main forms include direct funding (government procurement, grants) and indirect methods (tax incentives, creation of technology parks) aimed at implementing new technologies and creating high-tech infrastructure.

The main forms of state stimulation of STP are:

- Technological innovation: Financing breakthrough research and development (R&D) aimed at creating fundamentally new equipment and technologies.
- Technology dissemination: The state promotes the commercialization of scientific knowledge, technology transfer, and its implementation in the real sector of the economy.
- Infrastructure creation: Formation of technology parks, innovation centers, and clusters that provide links between science and production.
- Government procurement and grants: Direct funding of priority areas (e.g., AI, biotechnology, new materials).
- Tax and financial incentives: Reducing the tax burden on companies investing in innovation.
- Human capital development: Supporting the education system and training personnel for high-tech industries.

In the Republic of Belarus, the All-Belarusian People's Assembly approved the Program for Social and Economic Development of the Republic of Belarus for 2026–2030. This document notes that a number of systemic imbalances persist in the Republic of Belarus, including a low technological structure. In the manufacturing industry, the share of low- and medium-tech industries accounts for 62.8 percent of added value, while high-tech industries account for only 7.8 percent. A chronically low level of implementation of research and development results and patents, a weak science-production-education interaction mechanism, and a shortage of scientific personnel are noted.

This Program identifies several development priorities for the next five years, including increasing competitiveness, accelerating technological development, and digital transformation. The country has also approved the State Program for Innovative Development for 2026-2030, which, in particular, outlines the concentration of state support on the development, modernization, and implementation of critical technologies (goods) in order to overcome dependence on the import of such technologies (goods).The state program was developed taking into account proposals from scientists and experts for improving the scientific sphere, as well as the results of its implementation in 2021-2025.

More than 50 innovative projects have been successfully implemented, creating science-intensive and high-tech products worth Br17.4 billion, of which Br6.1 billion was exported. In the new five-year plan, public and private organizations will implement innovative projects to create new production facilities within the program's framework, aligned with the priority areas of scientific, technical, and innovative activity for 2026-2030. This will enable the successful development of domestic scientific and technological potential, increase the production of innovative products created using advanced domestic technologies, substitute critical imports, and strengthen the country's technological sovereignty.

As a result of the program's implementation, by 2030, the share of innovation-intensive organizations is expected to increase to 45%, and the volume of exports of science-intensive and high-tech products will reach €2.5 billion, including at least €550 million from technology park residents.

All of the above demonstrates the Republic of Belarus's desire to achieve technological sovereignty by leveraging the country's scientific, scientific-technical, and technological potential. The primary driver is its scientific potential, which is experiencing certain challenges, including an aging research workforce, access to funding, and isolation from global scientific thought due to sanctions.

5. Conclusions

We agree with Belyakov and Kochemaskin (2014) that ensuring the scientific and technological development of the economy is a complex task built on the interconnected development of all its component elements.

For the Republic of Belarus, the conclusion of Jiang and Mei (2016) that a scientific and technological intermediary can shape a compromising culture within a network, while moderate cultural diversity facilitates knowledge transfer, is of particular importance.

Based on the above, the following conclusions can be drawn. While considering the positive impact of scientific and technological progress, it is also necessary to consider the negative consequences. The Republic of Belarus is confidently on the path of scientific and technological progress.

The Republic of Belarus has not yet experienced the negative impact of scientific and technological progress. The only drawback is the isolation from scientific and technological developments due to sanctions. However, this encourages efforts to gain technological sovereignty. Therefore, it can be assumed that sanctions, for example, have a positive impact on scientific and technological progress in Belarus.

To achieve technological sovereignty, it is necessary to activate the innovation, start-up, and entrepreneurial ecosystems in Belarus.

6. References

Ayres, R. U. (1996). Technology, progress and economic growth. *European Management Journal*, *14*(5), 562–575.

Belarusian Institute of System Analysis and Information Support for Science and Technology. (n.d.). *Science and technology parks of the Republic of Belarus*. Retrieved April 9, 2026, from https://www.belisa.org.by/izdaniya/spravochnye-izdaniya/tekhnoparki_respubliki_belarus/

Belyakov, G. P., & Kochemaskin, A. N. (2014). The concept and economic essence of scientific and technological development. *Problems of Modern Economy*, (1(49)), 38–41.

Berdieva, O. G., Ataberdiev, D. Ch., & Baylieva, D. B. (2024). The future of technological progress and demand-pulled inflation in the modern economy. *Science Bulletin*, *2*(6(75)), 1435–1438.

Brown, T. E., & Ulijn, J. M. (Eds.). (2004). *Innovation, entrepreneurship and culture: The interaction between technology, progress and economic growth*. Edward Elgar.

Ding, X. (2015). Empirical research on technology progress and economic growth of Anhui Province. *Journal of Bengbu University*.

Égert, B. (2026). Spinning jennies and silicon: The economics of innovating or evaporating – Creative destruction and public policies. *Financial and Economic Review*, *25*(1), 100–130.

Gaipov, M., Geldinazarova, A., & Turaev, S. (2024). The role of innovations in economic growth. *Innovative Science*, (10-2-1), 81–82.

Galor, O., & Tsiddon, D. (1997). Technological progress, mobility, and economic growth. *The American Economic Review*, *87*(3), 363–382.

Gichiev, N. S. (2013). Determinants of economic growth: Foreign trade, foreign investment, technological progress. *Regional Problems of Economic Transformation*, (4(38)), 94–99.

Jiang, Y., & Mei, Q. (2016). Empirical research on the impact of social capital of a scientific and technological intermediary on knowledge transfer: Taking the Science and Technology Park of Nanjing University as an example.

Liu, Z., Tong, Z., & Zhang, Z. (2023). Government expenditure structure, technological progress and economic growth. *International Journal of Emerging Markets*.

National Statistical Committee of the Republic of Belarus. (n.d.). *Science and innovation statistics* [Data set]. Retrieved April 9, 2026, from https://dataportal.belstat.gov.by/osids/rubric–info/10614

Nazeer, N., & Rasiah, R. (2024). Technology transfer, technological progress and economic growth: The role of institutional quality in Pakistan. *Malaysian Journal of Economic Studies*.

Xin, Y. (2024). Institutional openness, technological progress and national economic growth – Evidence from the Belt and Road science and technology innovation cooperation policy. *Applied Economics Letters*, *32*(19), 2285–2290.

Zhu, H., Chen, B., Chang, S., & Zhu, H. (2024). The impact of financing efficiency in defense industry base on non-technological innovation: Evidence from China. *Managerial and Decision Economics*.