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# Impact of USA-China Technological Rivalry on Global Innovation and Economic Competitiveness: Comparative Analysis of National Strategies

**HANG XU***

**ZENGBIAO LIU***

## ABSTRACT

Technological rivalry between the United States and China is one of the most significant phenomena in modern international relations, influencing global innovation and economic competitiveness. **Objective.** To conduct a comparative analysis of US and Chinese national strategies for promoting innovation and to assess their impact on technological competitiveness in key areas. **Methodology.** A mixed methodology was applied, including content analysis of 99 official documents (2015-2024), quantitative analysis of OECD, WIPO, and Nature Index data, as well as a comparative case analysis of the US and China in five technological spheres: artificial intelligence, semiconductors, quantum technologies, biotechnology, and telecommunications. **Results.** The study identifies a "paradox of

* Peoples' Friendship University of Russia (RUDN University), Moscow, Russian Federation. E-mail: xu.hang@mymail.academy. ORCID: 0009-0003-7628-6260

* Samara State University of Economics, Samara, Russian Federation. E-mail: liu.zengbiao@mymail.academy. ORCID: 0009-0002-3096-4321


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technological leadership," in which China's model of state capitalism ensures quantitative dominance, while the US market-oriented system sustains qualitative leadership. Geopolitical competition accelerates innovation processes but also leads to the fragmentation of global technological ecosystems. **Conclusion.** In summary, a multipolar system of technological leadership is emerging, with countries specializing in particular fields.

**KEY WORDS:** State capitalism, Artificial Intelligence, National strategies, Patents, R&D, Leadership.

**Repercusiones de la rivalidad tecnológica entre EE. UU. y China en la innovación mundial y la competitividad económica: análisis comparativo de las estrategias nacionales**

**RESUMEN**

La rivalidad tecnológica entre Estados Unidos y China es uno de los fenómenos más relevantes de las relaciones internacionales modernas, ya que influye en la innovación mundial y en la competitividad económica. **Objetivo.** Realizar un análisis comparativo de las estrategias nacionales de Estados Unidos y China para promover la innovación y evaluar su impacto en la competitividad tecnológica en áreas estratégicas. **Metodología.** Se aplicó una metodología mixta que incluyó el análisis de contenido de 99 documentos oficiales (2015-2024), el análisis cuantitativo de datos de la OCDE, la OMPI y el Nature Index, así como un análisis comparativo de casos de Estados Unidos y China en cinco ámbitos tecnológicos: inteligencia artificial; semiconductores; tecnologías cuánticas; biotecnología y telecomunicaciones. **Resultados.** El estudio identifica una "paradoja del liderazgo

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tecnológico" en la que el modelo de capitalismo de Estado de China garantiza el dominio cuantitativo, mientras que el sistema orientado al mercado de EE. UU. mantiene el liderazgo cualitativo. La competencia geopolítica acelera los procesos de innovación, pero también conduce a la fragmentación de los ecosistemas tecnológicos globales. **Conclusión.** En suma, está surgiendo un sistema multipolar de liderazgo tecnológico en el que los países se especializan en campos concretos.

**PALABRAS CLAVE:** capitalismo de Estado, inteligencia artificial, estrategias nacionales, patentes, I+D, liderazgo.

## Introduction

Over the past decade, competition between the United States and China has evolved from trade disputes to a comprehensive strategic confrontation in key technological areas, including artificial intelligence (Pakshin, 2023), semiconductors, quantum technologies, and telecommunications (Triolo, 2023).

These areas have been selected as strategically critical for both countries: AI defines the future of the digital economy and national security, with both nations viewing leadership in AI as a key factor of global dominance. Semiconductors are a fundamental technology for all modern electronic devices and are critically important for national security. Quantum technologies have the potential to revolutionize cryptography, communications, and information processing, providing significant military advantages to the leading country. Telecommunications (5G/6G) form the infrastructural foundation of digital transformation (Abdullaev et al., 2023) and have dual-use applications.

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This strategic confrontation affects bilateral relations and drives the development of many national economies worldwide.

First, technological competition between the US and China affects more than 60% of global GDP through its impact on third countries and global supply chains.

Second, these two countries have developed fundamentally different national strategies for promoting innovation: the US emphasize a market-oriented approach with elements of export control and alliance-building, while China applies a model of state capitalism with large-scale subsidies and support for "national champions" (major state-owned or state-backed companies considered strategically important for the national economy and given special support to compete in global markets) (Danilin, 2024).

Third, this rivalry creates new challenges for international cooperation in science and technology (Stefanov, 2024). For example, in the field of AI, US export restrictions on advanced semiconductors (GPUs) and the equipment required for their production have significantly limited Chinese researchers' access to the high-performance computing resources necessary for training large language models. In the sphere of quantum technologies, US-China scientific cooperation has declined, with China adopting an insular approach characterized by limited international collaboration in research publications, while exchanges between the two countries' quantum laboratories have sharply decreased due to export restrictions and mutual distrust.

Thus, China's rapid technological rise, reflected in the growth of patent applications and scientific publications surpassing US figures in several fields, highlights the significance of this


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rivalry (Moon & Yeon, 2024). In AI, China is increasingly competing with American models: the Chinese company DeepSeek developed the R1 model, comparable to OpenAI ChatGPT o1 in key benchmarks, while spending only $6 million on training compared to the tens of billions of dollars invested by American competitors, despite restricted access to advanced chips. In the semiconductor sector, Chinese companies are actively expanding domestic production capacities: Huawei successfully released smartphones with the domestically produced 7-nanometer Kirin 9000S chip, manufactured by SMIC, while China's semiconductor self-sufficiency rose from 15% in 2019 to 25% in 2025, moving toward technological independence. In quantum technologies, China leads in quantum communications, having built the world's largest quantum communication network, spanning 12,000 km and including two quantum satellites. Since 2022, China has published more research papers on quantum technologies than any other country. In telecommunications, Chinese companies such as Huawei are challenging Western dominance, reentering the 5G smartphone market with domestic chips despite US sanctions. At the same time, the US is intensifying export control measures and restrictions on technology transfer, creating new conditions for global innovation processes. These include limits on the export of advanced semiconductors and related equipment, bans on investment in critical technologies, restrictions on scientific cooperation and talent exchange (Severin, 2023), and requirements for companies to choose between the American and Chinese technological ecosystems. Such measures stimulate the development of alternative innovation paths, encourage the creation of duplicative research programs, and accelerate processes of technological nationalism in both countries (International Institute for Strategic Studies, 2023).

## Literature Review

An analysis of the current literature identifies four main research directions: comparative analysis of national strategies, impact on global innovation ecosystems, the role of industrial policy and trade wars, and geopolitical and security aspects of technological competition. This

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typology is based on a systematic review of research approaches to the US-China technological rivalry in leading analytical centers, including the Brookings Institution, Belfer Center, and ITIF, which highlight similar conceptual frameworks for studying this phenomenon. **The comparative analysis of national innovation strategies** focuses on institutional differences in approaches to promoting R&D. The study of **the impact on global innovation ecosystems** examines the cross-border effects of national policies on international scientific and technological connections. **The role of industrial policy and trade wars** analyzes the relationship between trade measures and innovation activity. **Geopolitical and security aspects** consider technological rivalry in the context of national security and strategic planning.

The comparative analysis of national innovation competitiveness requires the use of a comprehensive set of quantitative indicators, each reflecting different aspects of national innovation systems. Patent applications demonstrate R&D effectiveness and the capacity to generate intellectual property; R&D funding indicates the priorities and scale of public and private investments in innovation; scientific publications reflect the fundamental research base; technological exports characterize the commercial competitiveness of innovations; and international indices provide a comprehensive assessment of innovation ecosystems. This multidimensional approach avoids one-sided evaluation and ensures a more objective comparison of US and Chinese innovation strategies.

**Comparative analysis of national innovation strategies**

Fundamental differences in the approaches of the US and China to promoting innovation have become a central topic in modern research. Authors emphasize the key role of local


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governments in China as active participants in technological competition, which distinguishes the Chinese model from the federal-private partnership in the US. Danilin (2024) describes the evolution of China's strategy from supporting large "national champions" to a more balanced approach that includes small- and medium-sized enterprises, referred to as "technology giants."

Authors conceptualize these differences as the manifestation of two separate models of digital capitalism: the state-directed Chinese system and the liberal market model of the US. This division leads to the formation of bifurcated technological spheres, i.e., separated technological ecosystems with incompatible standards, protocols, and limited data and technology exchange between them.

Scholars analyze China's AI strategy as a "whole-of-state" system, mobilizing national resources and integrating military and civilian sectors. In contrast, the US relies on a combination of export controls, alliance-building, and targeted industrial policies to maintain technological superiority.

**Impact of trade wars and industrial policy**

The trade war between the US and China escalated significantly in 2024-2025: the Trump administration imposed 145% tariffs on Chinese goods, while China responded with 125% tariffs on American products. In December 2024, the US expanded export restrictions by adding 140 Chinese companies to the blacklist aimed at limiting China's access to advanced semiconductor manufacturing equipment and AI technologies. In May 2025, the US banned


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the sale of semiconductor design software to Chinese companies, while China introduced export restrictions on critical rare-earth metals, including gallium and germanium.

Sun (2024) examines the impact of the trade war on the development of China's chip industry, noting that despite China's significant investments in localizing semiconductor production in response to US restrictions, a substantial gap between the American and Chinese sectors persists. Ju et al. (2024) propose a theoretical model showing how the interaction of trade wars and industrial policy can lead to different outcomes depending on the use of tariffs versus subsidies.

Zhang (2020) emphasizes that the trade war reflects a broader contest for technological leadership, in which the US seeks to constrain China's industrial policies aimed at promoting technological innovation. Zhou and Fang (2020) analyze the compliance of Chinese industrial subsidies with WTO rules, proposing a more nuanced subsidy regulation that balances trade fairness with political space for innovation.

**Impact on global iInnovation ecosystems**

Research shows that the US-China rivalry significantly disrupts global innovation ecosystems. Triolo (2023) analyzes how US dominance in supply chains limits China's access to innovations, particularly in the semiconductor sector.

Schindler and Rolf (2025) examine the role of multinational corporations in mediating or accelerating the fragmentation of global production networks. Their analysis shows that

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geopolitical risks force companies to choose between hedging and aligning with the dynamics of the US-China rivalry.

Degterev et al. (2023) demonstrate how 5G competition between the US and China leads to technological fragmentation in Latin America, creating separate techno-economic blocs in the region. This study is important for understanding how rivalry extends into regional markets.

**Geopolitical and security aspects**

The growing body of literature links technological competition to the issues of national security and geopolitical power (Yakovleva, 2024). Gawi and Abdullahi (2024) emphasize the critical importance of emerging technologies such as AI, 5G, and cybersecurity for economic and military strength, calling for the US-China cooperation on the ethical use of technologies (Gawi & Abdullahi, 2024).

Moon and Yeon (2024) introduce the concept of “techno-statism” to explain the deepening of high-tech rivalry between the US and China, analyzing the dilemmas faced by middle powers.

Danilin conceptualizes the US strategy as “neo-techno-nationalism,” focusing on the control of global human capital and data to maintain a systemic techno-economic regime. Authors emphasize the cultural and geopolitical differences shaping technological rivalry, including American individualism versus Chinese Confucian state-business relations.

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**Contribution of this study**

This study seeks to address the identified gaps by conducting a comprehensive comparative analysis of US and Chinese national strategies for promoting innovation, focusing on their impact on competitiveness in key technological areas. It proposes an integrated approach that combines the analysis of policy instruments, innovation outcomes, and global implications.

**Methods**

**Research design**

This study employs mixed methods, combining qualitative comparative analysis with quantitative assessment of innovation performance indicators. The selection of a mixed methodology is driven by the complexity of the phenomenon under examination, which requires both an in-depth understanding of state strategies and an empirical evaluation of their effectiveness.

The primary methodological framework is a comparative case study, in which the US and China are examined as two contrasting cases of implementing state-led innovation strategies. This approach allows us to identify cause-and-effect relationships between differences in strategic approaches and their impact on competitiveness.

**Sample and selection criteria**


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The temporal scope of the study covers the period from 2015 to 2024. The lower limit is determined by China's adoption of the Made in China 2025 strategy in 2015 which marked a new stage in technological competition. The upper limit is defined by the availability of up-to-date data.

The criteria for including documents in the analysis are as follows (Table 1).

**Table 1.** Criteria for including documents in the analysis

| Inclusion criteria for documents | Exclusion criteria for documents |
|---|---|
| Official strategic documents and legislative acts of the US and China in the field of innovation policy | Documents at the local or regional level (except when they illustrate federal policy) |
| Documents related to key technological areas: AI, semiconductors, quantum technologies, biotechnology, 5G/telecommunications | Unofficial sources and media materials |
| Publications in English, Chinese, or Russian | Documents not directly related to innovation policy |
| Availability of the full text of the document | Documents with restricted access or incomplete data |

**The key technological areas** for analysis were selected based on their strategic importance, determined by the following criteria: (1) their designation as priorities in official strategic documents of both countries, including "Made in China 2025", the US National AI Strategy, and the CHIPS Act; (2) the scale of public R&D funding in these areas (Moon & Yeon, 2024); (3) specific export restrictions and trade measures (Triolo, 2023); (4) their coverage in analytical reports of leading research centers as critical to national security (Gawi & Abdullahi, 2024) for both countries, as well as the availability of sufficient data (Figure 1).

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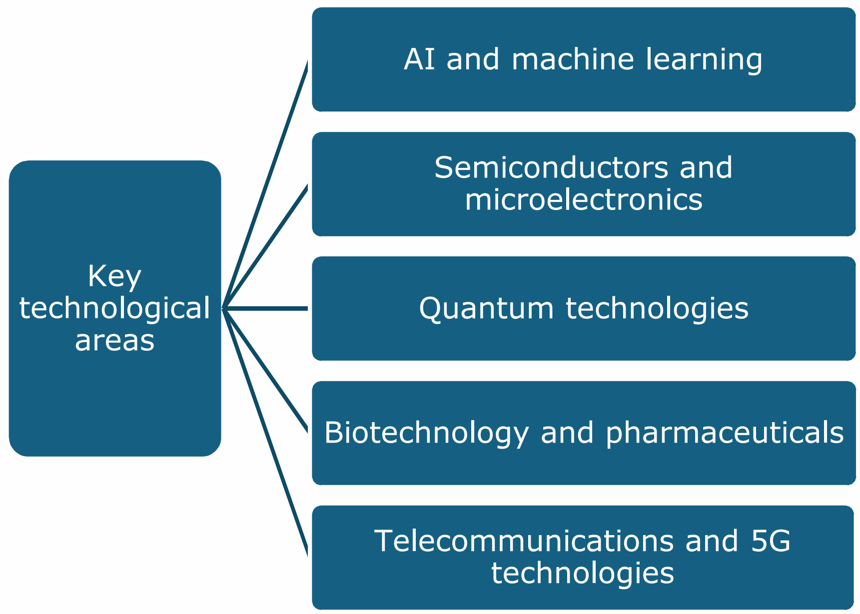


**Figure 1.** Key technological areas for research

## Data collection methods

The study uses secondary data analysis from the following sources (Table 2).

**Table 2.** Sources for secondary data analysis

| Type of sources and time frame | Specific sources (references) |
|---|---|
| **Documentary sources (2015-2024)** | |
| Strategic documents of the US and China | Danilin, 2024 |
| Legislative acts and regulations | International Institute for Strategic Studies, 2023 |
| Government agency reports | Moon & Yeon, 2024; Triolo, 2023 |


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| **Quantitative indicators (2015-2024)** | |
|---|---|
| Patent data and R&D | World Intellectual Property Organization, n.d. |
| Scientific publications and citations | Park, 2023 |
| Technological export indicators | Petri, 2019 |
| **Expert assessments (2020-2024)** | |
| Analytical reports | Stefanov, 2024 |
| Industry studies | Gawi & Abdullahi, 2024 |

**Data analysis procedures**

**The qualitative analysis** includes:

1. **The content analysis of documents** using a structured coding scheme:

- **Goals and priorities of innovation policy**: Identification of declared objectives for technological development, time horizons for achieving technological leadership, and priority areas of state intervention in innovation processes.

- **Mechanisms of state support**: Systematization of innovation promotion tools by category (financial – subsidies, grants, tax incentives; regulatory – standards, certification; institutional – establishment of specialized agencies, technology parks).

- **Target technological areas and time horizons**: Analysis of state attention on different technological sectors and the planned timelines for achieving specific technological breakthroughs.

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- **Measures for intellectual property protection**: Examination of approaches to patent policy, protection of trade secrets, and regulation of technology transfer.

- **International cooperation and restrictions**: Identification of attitudes toward international cooperation versus protectionist measures and restrictions on foreign participation in national innovation programs.

2. **The comparative analysis of policy instruments** comprises:

- **Typology of innovation support instruments**: Classification of state support measures by mechanism of influence (direct funding, indirect incentives, infrastructure development, regulatory measures) and comparison of US and Chinese preferences in the selection of specific tools.

- **Comparison of the scale and orientation of public funding**: Quantitative analysis of budget allocations for R&D, the share of public funding in total innovation expenditures, and the sectoral distribution of government investments between basic research, applied development, and commercialization.

- **Analysis of institutional mechanisms for policy implementation**: Comparison of organizational structures of innovation governance (centralized versus decentralized models), the role of different agencies in coordinating innovation policy, and mechanisms of state interaction with the private sector and academic institutions.

**Quantitative analysis** includes:


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1. **Descriptive statistics** of innovation activity indicators, calculating:

• Mean values and trends for key indicators

• Comparative growth rates between the US and China.

• Structural analysis by technological areas.

2. **Index-based analysis** of competitiveness, including:

• Calculation of Revealed Comparative Advantage (RCA) indicators in technological exports.

• Analysis of specialization in patent activity.

• Comparison with international innovation rankings.

**Ensuring validity and reliability**

**Internal validity** is ensured through:


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• Triangulation of data from multiple sources

• Cross-checking consistency between official documents and statistical data

• Use of time-series data to identify causal relationships.

**External validity** is limited by the focus on two cases (the US and China). However, the findings can still be relevant for understanding different models of state-driven innovation promotion.

**Reliability** is ensured through:

• Standardized procedures for document coding.

• Use of official and verified data sources.

• Transparency of criteria for material selection and analysis

## Results

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The analysis of OECD Main Science and Technology Indicators revealed significant changes in the structure of global R&D funding over the study period.

Table 3. Gross domestic expenditure on R&D (GERD) in the US and China (USD billion, PPP)

| Year | US | China | US/China ratio |
|---|---|---|---|
| 2015 | 496 | 409 | 1.21:1 |
| 2017 | 549 | 496 | 1.11:1 |
| 2019 | 656 | 555 | 1.18:1 |
| 2021 | 806 | 668 | 1.21:1 |
| 2023 | 823 | 723 | 1.14:1 |

Note. Data are presented in USD based on purchasing power parity (PPP). Although the US remains the leader in total R&D expenditures, the gap with China has significantly narrowed.

Trends show that China increased its share of global R&D spending from 4% in 2000 to 26% in 2023, while the US share decreased from 37% to 29% over the same period.

Furthermore, analysis of WIPO data indicates fundamental changes in the global patent landscape.

**Table 4.** Patent applications in key technological areas (number of applications)

| Area | 2019 | | 2023 | |
|---|---|---|---|---|
| | US | China | US | China |
| Total number of patent applications | 621,453 | 1,402,000 | 598,085 | 1,680,000 |
| AI | 20,845 | 68,400 | 18,902* | 38,210** |

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| | | | | |
|---|---|---|---|---|
| Semiconductors and computer technology | N/A | N/A | N/A | 60%*** |
| Telecommunications | N/A | N/A | N/A | 33%*** |

Note. *AI data for the USA in 2023 are approximate estimates. **Data on generative AI in China cover the period 2014-2023. ***Share of global applications according to WIPO data.

China filed 1.68 million patent applications in 2023 (an increase of 3.6% compared to 2022), nearly three times the US figure (598,085 applications).

The Nature Index data show a shift in leadership in high-quality scientific publications.

**Table 5.** Nature Index Share indicators for the US and China

| Year | US | China | Gap (China-US) |
|---|---|---|---|
| 2015 | 18,365 | 9,721 | -8,644 |
| 2019 | 18,590 | 15,880 | -2,710 |
| 2021 | 17,610 | 16,049 | -1,561 |
| 2022 | 17,610 | 19,373 | +1,763 |
| 2023 | N/A | N/A | N/A |
| 2024 | 22,083 | 32,122 | +10,039 |

Note. The Nature Index Share is a metric that accounts for the share of authors from a given country in each article. In 2022, China surpassed the US for the first time, and by 2024, the

Among the world's top 10 research institutions according to Nature Index 2024, seven were Chinese, including the Chinese Academy of Sciences (Share: 2,243.22), which is almost twice ahead of Harvard University (Share: 1,143.43).


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The analysis of trade data revealed changes in the technological competitiveness of the two countries.

**Table 6.** The US-China semiconductor trade (USD billion)

| Indicator | 2019 | 2021 | 2023 |
|---|---|---|---|
| US exports to China (semiconductors) | 4.6 | 5.4 | 9.8 |
| US imports from China (semiconductors) | N/A | N/A | N/A |
| China's share in legacy chip production | 19% (2015) | N/A | 33% |
| US share in legacy chip production | 14% (2015) | N/A | 12% |

Note. The data show growth in US semiconductor exports to China despite imposed restrictions. At the same time, China significantly increased its share in the production of legacy chips.

The introduction of US export controls in 2022-2023 created a natural experiment for assessing the impact of trade measures on the innovation activity of both countries (Table 7).

**Table 7.** Impact of export restrictions on innovation activity

| Indicator | Before restrictions (2018-2019) | After restrictions (2022-2023) |
|---|---|---|
| China's R&D expenditures in semiconductors (growth, %) | High | Continued strong growth |
| Share of Chinese equipment in the domestic market | 5-7% | 9.6-15% |
| Price of Nvidia RTX 4090 in China | $1,200-1,500 | $5,500-6,900 |

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| | | |
|---|---|---|
| Investments of China's Big Fund | $19.2 billion (2014) | $7.1 billion in YMTC alone |

Note. Export restrictions have led to a sharp increase in the prices of restricted products, but have also stimulated large-scale state investments in the development of domestic technologies.

The overall analysis highlights a shift in the balance of technological leadership between the US and China.

**Table 8.** Comparative positions of the US and China in key technological areas

| Area | Leader in 2015 | Leader in 2023 | Main indicator |
|---|---|---|---|
| Total R&D expenditures | US | US | $823 billion vs. $723 billion |
| Patent applications | US | China | 1.68 million vs. 0.6 million |
| High-quality publications | US | China | Nature Index Share |
| AI patents | US | China | 38210 vs. ~19000 |
| Semiconductor manufacturing | N/A | Competition | China leads in legacy, the US in advanced |

The data indicate a shift of technological leadership from the US to China in most quantitative indicators, while the US retains qualitative superiority in several areas.


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The results of the quantitative analysis demonstrate large-scale changes in the global technological landscape over the study period and provide a basis for further discussion and interpretation of the identified patterns.

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The results of the quantitative analysis demonstrate large-scale changes in the global technological landscape over the study period and provide a basis for further discussion and interpretation of the identified patterns.

## Discussion

The results reveal fundamental changes in the global technological landscape, confirming the hypothesis that differences in national strategies for promoting innovation have a significant impact on the competitiveness of the US and China. The most important finding is the demonstration that quantitative indicators of innovation activity do not always correlate with the qualitative characteristics of technological leadership.

The data highlight a phenomenon that can be described as the "paradox of technological leadership": despite the US maintaining leadership in total R&D expenditures ($823 billion vs. $723 billion in 2023), China significantly outpaces it in most quantitative indicators of innovation activity. This contradiction is explained by the differences in the strategic approaches of the two countries.

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The American model focuses on maintaining qualitative superiority through high investment in fundamental research (15% of total R&D expenditures allocated to basic research vs. 67% to experimental development), while the Chinese strategy is aimed at large-scale expansion of quantitative indicators. This is consistent with the conclusions of Schmalz (2024) regarding the difference between China's state-directed system and the US liberal market model.

An analysis of the effectiveness of public investment reveals fundamental differences in approaches. Chinese investments show higher returns in quantitative indicators: with R&D expenditures increasing 1.77 times (from $409 billion to $723 billion during 2015-2023), the country achieved nearly a threefold advantage in patent applications (1.68 million vs. 0.6 million).

This confirms the effectiveness of the "national champions" model described in studies (Danilin, 2024), where local governments act as active participants in technological competition. However, the American model demonstrates greater effectiveness in creating technologies with high added value and commercial potential.

The research findings confirm the forecasts (Moon & Yeon, 2024) regarding the deepening of "techno-statism" as the dominant paradigm of the US-China rivalry. The increase in China's share in the Nature Index from 9.721 in 2015 to 32.122 in 2024 demonstrates precisely the trajectory predicted by scholars of technological competition.

A particularly important finding is the confirmation of the conclusions in regarding the "digital paradox of power": despite US export restrictions, Chinese companies have continued to strengthen their technological capabilities. The increase in China's share of semiconductor

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equipment in the domestic market from 5-7% to 9.6-15% during the sanctions period highlights the limited effectiveness of “weaponized interdependence.”

The threefold increase in the price of Nvidia RTX 4090 in China (from $1,200-1,500 to $5,500-6,900) did not lead to a decline in innovation activity but stimulated the development of alternative solutions, including breakthroughs in carbon nanotubes and 2D transistors reported in 2025.

The analysis identifies three key mechanisms through which national strategies influence technological competitiveness.

**Scaling mechanism (China):** State mobilization of resources through the Big Fund ($19.2 billion initially, plus an additional $7.1 billion invested in YMTC alone) enables rapid growth in quantitative indicators. This explains the increase in China’s share of global patent applications from 25% in 2015 to more than 50% in 2023.

**Quality selection mechanism (US):** A market-oriented approach with elements of strategic control ensures the concentration of resources on breakthrough technologies. The continued US leadership in fundamental research ($119 billion in 2021) and in highly cited publications confirms the effectiveness of this approach.

**Adaptive response mechanism:** Export restrictions paradoxically accelerate innovation processes in both countries, creating incentives for technological independence.

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Nature Index data show a decline in the share of international collaboration in Chinese publications, which confirms the concept of “technological nationalism”. This creates risks of fragmenting the global innovation ecosystem, as warned in (Triolo, 2023) and (Schindler & Rolf, 2025).

The research findings also confirm the emergence of “bifurcated technological spheres,” conceptualized in (Schmalz, 2024). The growth of Chinese leadership in AI patents (38,210 applications vs. about 19,000 in the US), alongside the continued American advantage in qualitative indicators, points to the development of parallel, loosely connected technological ecosystems.

This has significant implications for third countries, which are forced to choose between technological standards, as illustrated in the study (Degterev et al., 2023) on the implementation of 5G in Latin America.

Contrary to expectations, the results show that geopolitical competition accelerates rather than slows down innovation processes. The increase in China’s R&D spending on semiconductors, alongside rising US investments under the CHIPS Act, creates an innovation race that may benefit global technological progress, despite the fragmentation of cooperation.

The results call for a reevaluation of classical theories of national innovation systems. Traditional models, based on the assumption that international cooperation is crucial for technological progress, do not fully explain the phenomenon of accelerated innovation under the conditions of geopolitical competition.

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The concept of “competitive innovation systems” is proposed, in which interstate rivalry becomes a key driver of technological development, compensating for reduced international cooperation through intensified domestic efforts.

The findings point to the emergence of a multipolar technological system characterized by the absence of a single leader, country specialization in specific domains, and rapid shifts in leadership across different sectors.

## Conclusions

The practical significance of the results lies in understanding the multidimensional nature of technological leadership and the need to rethink strategies for international cooperation. The scientific significance lies in conceptualizing a new understanding of technological rivalry as a driver of innovation.

The study has methodological limitations related to differences in data collection between countries and the possible overstatement of Chinese indicators due to state incentives. The nine-year observation period may be insufficient for long-term conclusions, while the complexity of attributing the effects of specific measures creates challenges in establishing cause-and-effect relationships. Limited access to Chinese sources may also affect the completeness of the analysis.

## References

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Abdullaev, I., Prodanova, N., Ahmed, M.A., Lydia, E.L., Shrestha, B., Joshi, G.P., & Cho, W. (2023). Leveraging metaheuristics with artificial intelligence for customer churn prediction in telecom industries. Electronic Research Archive, 31(8), 4443-4458. https://doi.org/10.3934/era.2023227

Danilin, I.V. (2024). ‘National champions’ and technological ‘little giants’: Chinese industrial policy between modernization and tradition. MGIMO Review of International Relations, 17(6), 139-154. http://dx.doi.org/10.24833/2071-8160-2024-6-99-133-148

Degterev, D.A., Piskunov, D.A., & Eremin, A.A. (2023). U.S. – China rivalry in Latin America: At the origins of technological decoupling. Polis. Political Studies, 3, 20-38. http://dx.doi.org/10.17976/jpps/2023.03.03

Gawi, Y.A., & Abdullahi, A. (2024). The competition between the United States and China in the emerging technologies and its implications on the associated national security. Journal of Global Social Sciences, 5(18), 39-54. http://dx.doi.org/10.58934/jgss.v5i18.266

International Institute for Strategic Studies. (2023). Technology trade controls and US–China competition. https://www.iiss.org/publications/strategic-comments/2023/technology-trade-controls-and-us-china-competition/

e-issn 2389-8194

Ju, J., Ma, H., Wang, Z., & Zhu, X. (2024). Trade wars and industrial policy competitions: Understanding the US-China economic conflicts. Journal of Monetary Economics, 141, 42-58. https://doi.org/10.1016/j.jmoneco.2023.10.012

Moon, C., & Yeon, W. (2024). Clashes of techno-statecraft: US-China technology rivalry and South Korea's strategy. Business and Politics, 1-21. http://dx.doi.org/10.1017/bap.2024.26

Pakshin, P.K. (2023). The legal regulation of artificial intelligence systems in private international law. Gaps in Russian Legislation, 16(6), 99-105. https://doi.org/10.33693/2072-3164-2023-16-6-099-105

Park, Y.S. (2023). US-China strategic competition amidst the paradox of decoupling. International Journal of Social Science Studies, 12(1), 1-13.

Petri, P.A. (2019). United States-China technological rivalry. https://dx.doi.org/10.2139/ssrn.3441035

Schindler, S., & Rolf, S. (2025). Geostrategic globalization: US–China rivalry, corporate strategy, and the new global economy. Globalizations, 22(6), 897-914. http://dx.doi.org/10.1080/14747731.2024.2434306

e-issn 2389-8194

Schmalz, S. (2024). Varieties of digital capitalism and the US-China rivalry: The rise of competing technological spheres. Critical Sociology, 51(4-5), 867-886. http://dx.doi.org/10.1177/08969205241291645

Severin, V.A. (2023). Integrated approach of personnel training for cybersecurity: Challenges and problems. Lobbying in the Legislative Process, 2(2), 16-20. https://doi.org/10.33693/2782-7372-2023-2-2-16-20

Stefanov, N. (2024). The US and the 'collective West' vs. China: The 'trade' and 'technological wars' in the 2nd and 3rd decades of the 21st century. Geopolitical Review, 9(1), 59-74.

Sun, M. (2024). A comparative study on the development of chip industry between the two countries under the background of Sino-US conflict. Frontiers in Business, Economics and Management, 17(3), 67-70. http://dx.doi.org/10.54097/azh12v83

Triolo, P. (2023). Technology crossroads: Innovation in China's telecommunications and high-performance computer sectors threatened by US stranglehold on semiconductors. Asian Security, 19(2), 143-158.

World Intellectual Property Organization. (n.d.). IP facts and figures: Patents. https://www.wipo.int/en/ipfactsandfigures/patents

e-issn 2389-8194

Yakovleva, A.V. (2024). Legal regulation in the field of cybersecurity of intelligent transport (foreign experience). Gaps in Russian Legislation, 17(3), 37-43. https://doi.org/10.33693/2072-3164-2024-17-3-037-043

Zhang, K.H. (2020). Industrial policy and technology innovation under the US trade war against China. The Chinese Economy, 53(5), 363-373. http://dx.doi.org/10.1080/10971475.2020.1730553

Zhou, W., & Fang, M.M. (2020). Subsidizing technology competition: China's evolving practices and international trade regulation. Washington International Law Journal, 30(3), 470-544.