

**Dmitriy V. GALUSHKO\***

**Financial University under the Government of the Russian Federation**

## **THE INTERTWINED PATHS OF STATE SOVEREIGNTY AND TECHNICAL SOVEREIGNTY**

*The article examines the relationship between state sovereignty and technological sovereignty in the context of digital transformation and geopolitical competition. The author analyses the evolution of the concept of sovereignty, which is expanding to include a technological component that has become a key factor in national security and economic resilience. Special attention is paid to the legal aspects of technological sovereignty, including mechanisms to counter external pressure, import substitution of critical technologies, and the formation of a national innovation ecosystem.*

*Using the Russian Federation as a case study, the article explores strategic and regulatory measures aimed at ensuring technological sovereignty, such as the adoption of the Federal Law "On Technological Policy in the Russian Federation," the development of lists of critical and cross-cutting technologies, and implementing national projects in digitization and scientific-technological development. Some argue that, in modern conditions, technological sovereignty is transforming from an economic category into a systemic element of state sovereignty, requiring comprehensive legal regulation.*

*The article proposes conceptual approaches to strengthening technological sovereignty through resilience to external threats, ensuring economic competitiveness, and safeguarding national independence. The research findings have both theoretical and practical significance for shaping technological development strategies in the new geopolitical reality.*

**Keywords:** state sovereignty, technological sovereignty, digital transformation, national security, critical technologies, legal regulation, import substitution, geopolitical competition.

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\* PhD, Professor of the Department of Legal Regulation of Economic Activities, ORCID: 0000-0002-9301-9565, e-mail: galushkodv@gmail.com

## 1. INTRODUCTION

At the beginning of the 21st century, technological progress has ceased to be merely a factor of economic growth, transforming instead into a crucial element of national security and state sovereignty. The global digital transformation, rapid development of artificial intelligence, quantum computing, biotechnology, and other critical areas have led to the emergence of a new world order paradigm where technological dominance serves as the foundation of geopolitical influence. In this context, the traditional boundaries of state sovereignty are expanding to encompass a nation's ability to independently determine its technological development trajectory, control strategic infrastructure, and protect its digital sovereignty (Ivanov, 2024).

This issue has gained particular relevance against the backdrop of intensifying geopolitical competition and sanctions pressure, most notably manifested against the Russian Federation after 2022 (Porohovskij, 2023). Restrictions on high-tech product supplies, disconnection from international payment systems, and blocked access to foreign digital platforms and semiconductor technologies have exposed the vulnerability of states dependent on external technological supply chains. These developments have vividly illustrated how technological dependence can be weaponized as a tool of political and economic coercion, challenging the very possibility of exercising sovereign rights in the digital age.

The current stage of international relations is characterized by the formation of "techno-blocs" — groups of countries united around technological leaders (the United States, China, and the EU) that seek to ensure their dominance through control over critical standards, patents, and production capacities. In this regard, technological sovereignty is no longer purely an economic category but is evolving into a fundamental aspect of national security and legal regulation, requiring comprehensive doctrinal understanding and systematic implementation at all levels of state governance (Edler *et al.*, 2021).

The legal aspects of technological sovereignty demand profound consideration within the framework of international law, constitutional norms, and sectoral legislation. Under conditions of sanctions and technological restrictions, a complex of questions arises for the state: what are the legal mechanisms for protecting technological sovereignty under external pressure? How can national legislation be ensured to meet the challenges of the digital age without isolating itself from global innovation processes? What international legal instruments can be utilized to counteract discriminatory restrictions in the technological sphere?

The Russian Federation, facing an unprecedented volume of sanctions, is compelled to actively shape a new model of technological independence, requiring not only economic and industrial measures but also the improvement of legal regulation. The adoption of the Strategy for Scientific and Technological Development, initiatives for import substitution in the IT sphere, the development of a national payment system, and data protection within the framework of "digital sovereignty" — all of this testifies to the search for new legal and organizational solutions (Dudin *et al.*, 2022).

Therefore, the study of the correlation between state and technological sovereignty acquires not only theoretical but also practical significance for ensuring national security.

## 2. THE CONCEPT OF STATE SOVEREIGNTY

Classical legal doctrine views state sovereignty as a fundamental attribute of the state, encompassing two interconnected components: internal (supremacy of state power) and external (independence in international relations) (Galushko, 2013).

The legal essence of the category of «sovereignty» was among the first to be examined by the French constitutionalist Léon Duguit, who noted that sovereignty is an informal legal category endowed with a distinct authoritative content capable of organizing populations and subordinating one state to another. Sovereignty inherently encompasses the concept of territory. Territory and the nation-state are inextricably linked categories that have developed historically. As Duguit emphasized, a collective can only constitute a state when it exists within defined territorial boundaries. The essence of sovereignty, in his view, was embodied in supreme authority upheld by domestic legal order (Duguit, 1919).

Georg Jellinek further elaborated on this notion, stating that sovereignty is the capacity for exclusive legal self-determination. Thus, only a sovereign state can, within the limits of the legal boundaries it establishes or recognizes - absolutely and freely define the scope of its competence (Jellinek, 2002). Carl Schmitt's seminal contribution to sovereignty theory redefined its political dimension, distinguishing it from mere monopolies on power or coercion. For Schmitt, sovereignty instead constitutes the status of the supreme and ultimate authority within a defined territorial order—an authority vested with the prerogative to make final and irrevocable decisions, particularly in exceptional circumstances, that transcend normative legal frameworks (Schmitt, 2014). This decisionists' approach underscores sovereignty's existential role in determining the very boundaries of legal and political order.

Contemporary legal and political scholarship engages with sovereignty through diverse analytical lenses. From a juridical perspective, sovereignty is frequently conceptualized as the necessary foundation of a politically organized society, embodying the supreme authority that possesses both the exclusive right and the obligation to render definitive judgments on matters essential to collective existence. This authority's autonomous nature — manifested through the capacity for self-determined action — enables the maintenance of internal societal order and institutional coherence, while simultaneously safeguarding the state's independence from external subordination.

From an international legal standpoint, sovereignty serves as a cornerstone of contemporary international public law. This politico-legal attribute enables independent states to exercise exclusive authority in determining their political systems, structuring domestic governance, legislating, asserting territorial supremacy via jurisdictional control, and conducting foreign relations within their sovereign domain (Moiseev, 2007). The supremacy of state power is demonstrated through its universal applicability to all individuals and institutions within the territory, the exclusive right to legitimate coercion, the formalized exercise of authority through prescribed legal channels, and the capacity to invalidate acts by non-state entities that contravene the national legal framework. Concurrently, the independence of state power reflects absolute autonomy in both domestic and international affairs, encompassing sovereign policymaking, the establishment of equitable interstate relations, and freedom from external interference (Zhuleva, 2022).

Prominent scholar Georg Sørensen identifies the core components of sovereignty as «a clearly defined territory, a stable population, and a government possessing constitutional independence and operating within the international community of states» (Sørensen, 1999). Neil Walker offers a nuanced alternative, arguing that sovereignty encapsulates three defining features of the modern state: internal coherence, external independence, and the supremacy of law (Walker, 2003).

In constitutional jurisprudence, sovereignty operates dialectically as both a foundational precondition for state formation and a constitutive element of established constitutional orders. This dual character causes its explicit normative recognition and institutional protection within constitutional frameworks. As the central organizing principle of modern statehood, sovereignty provides the essential juridical basis for understanding the state's ontological status and its fundamental political-legal attributes. It simultaneously legitimizes governmental authority within defined territorial boundaries while serving as the axiomatic foundation for any constitutional system.

The analytical examination of sovereignty requires distinguishing between its two constitutive dimensions: the formal-legal, which represents sovereignty's institutional and procedural manifestations within constitutional structures, and the substantive, which encompasses its practical exercise in governance and power relations. This methodological distinction proves indispensable for resolving theoretical antinomies in sovereignty discourse.

The operational reality of sovereignty emerges most clearly through its fundamental internal-external dichotomy. Internally, the sovereign state embodies the ultimate *pouvoir constituant*, exercising plenary constitutional authority to determine its institutional architecture and normative order. This supreme internal authority, conceptually traceable to Bodin's theory of *maiestas*, establishes an absolute jurisdictional command over all subordinate entities within its territory. Externally, sovereignty manifests as the principle of autonomous statehood in international relations, though this autonomy exists in dynamic tension with the competing sovereignty claims of other states and the normative framework of international law. The contemporary international legal system thus re-conceptualizes sovereignty as a fundamentally relational construct, requiring states to navigate a complex balance between reciprocal limitations on their authority and the preservation of their essential independence (Jacque, 2021).

While historical political entities similarly claimed absolute internal authority, contemporary sovereignty requires more than unilateral control. Modern international law establishes sovereignty as inherently relational, depending on reciprocal recognition among states within the international community. This mutual acknowledgment transforms sovereignty from an absolute claim into a principle that both enables and constrains state power through its interaction with the international legal order. The contemporary understanding of sovereignty thus reflects the complex realities of international relations while preserving sovereign equality as a fundamental protection against external domination (see further: Wallerstein, 1999).

Substantively, sovereignty's internal dimension rests on three essential pillars: (1) exclusive territorial control, (2) unfettered authority over natural resources, and (3) the

monopoly on legitimate legal enforcement. Its external dimension guarantees: territorial integrity, protection from unlawful intervention, and autonomous decision-making capacity in international affairs. As Cardin Le Bret's enduring maxim affirms — “sovereignty is as indivisible as a geometric point” — this concept represents both the fundamental precondition for statehood and its defining characteristic, an inalienable attribute whose loss equates to the termination of international legal personality (Costa & Zolo, 2007). The constitutional order serves as the crucial framework for maintaining this delicate equilibrium between sovereignty's internal and external dimensions in an increasingly interconnected world. However, contemporary sovereignty operates within the practical constraints imposed by international cooperation imperatives. The complex web of treaty obligations, customary norms, and institutional frameworks causes voluntary self-restraint while preserving sovereignty's essential core — a paradox particularly clear during late 20th century globalization. Modern jurisprudence unanimously affirms that genuine sovereignty requires both internal and external dimensions (Podosinnikova, 2024), with federal sub-units lacking independent external relations capacity and constrained by constitutional limitations representing administrative divisions rather than sovereign entities (Jakovlev, 2024).

Sovereignty's key attributes — unity, indivisibility, and inalienability — establish its fundamental constitutional parameters. Unity mandates a single sovereign authority, excluding territorial subdivisions' independent claims. Indivisibility preserves the plentitude of state power, while inalienability permits only temporary, voluntary limitations through international cooperation, as shown by Russia's participation in the Eurasian Economic Union (Galushko, 2021).

The territorial dimension remains paramount despite contemporary challenges, as effective jurisdiction requires control over defined geographical space. Sovereignty violations now encompass both direct military intervention and indirect coercion, undermining national interests. Digital transformation has introduced new sovereignty dimensions, particularly technological sovereignty — a state's capacity to control critical technologies, digital infrastructure, and innovation processes (Varlen, 2023). This emerging paradigm complements traditional sovereignty concepts while addressing 21st-century geopolitical realities, where technological autonomy becomes inseparable from national security and authentic political independence.

### **3. TECHNOLOGICAL SOVEREIGNTY IN COMPARATIVE PERSPECTIVE**

The concept of technological sovereignty has emerged as a central pillar of national security and economic strategy in the 21st century, reflecting the growing recognition that technological capabilities determine a nation's position in the global hierarchy of power. As digital transformation reshapes every aspect of modern society from warfare to economic production, major powers have developed distinct yet interrelated strategies to secure control over critical technologies. The European Union, United States, and China represent three paradigmatic approaches to technological sovereignty, each reflecting unique historical trajectories, political systems, and geopolitical ambitions.

The European Union's approach to technological sovereignty represents a distinctive model that blends regulatory power with economic integration, reflecting both the strengths and limitations of its supranational governance structure. Unlike traditional nation-states, the EU has pursued technological sovereignty primarily through its formidable legal and regulatory apparatus, establishing itself as a global standard-setter in the digital realm. The General Data Protection Regulation (GDPR), implemented in 2018, exemplifies this strategy, creating a comprehensive framework for data protection that has become a *de facto* global standard while asserting European control over how international tech companies operate within its jurisdiction (GDPR, 2016). This regulatory approach extends to the recent Digital Markets Act and Digital Services Act, which aim to reduce European dependence on American tech giants by creating a more balanced and competitive digital marketplace (Digital Markets Act, 2022; Digital Services Act, 2022). In strategic industries like semiconductors, the EU has moved beyond regulation to direct industrial policy, with the Chips Act of 2022 committing €43 billion to double Europe's share of global semiconductor production to 20% by 2030 (Communication, 2022). The European approach reflects what officials term “open strategic autonomy” — an attempt to maintain technological independence while preserving commitments to multilateral cooperation and open markets (European Commission, 2021). This delicate balance illustrates the EU's distinctive challenge: asserting technological sovereignty within a framework of economic interdependence and shared governance that inherently limits member states' individual capacities for autonomous action. The European model shows how technological sovereignty can be pursued through legal and regulatory frameworks rather than purely through state-directed industrial policy, though recent initiatives suggest a growing recognition that regulation alone may be insufficient in key strategic sectors.

China's path to technological sovereignty presents a stark contrast to the European model, characterized by comprehensive state planning, aggressive industrial policy, and an explicit linkage between technological development and national security. The “Made in China 2025” initiative, launched in 2015, encapsulates Beijing's determination to achieve dominance in ten key technology sectors, ranging from artificial intelligence to advanced marine engineering and aerospace equipment (State Council, 2015). Unlike the EU's regulatory focus, China has pursued technological self-sufficiency through massive state investment in research and development, totaling over 2.4% of GDP in 2022, coupled with policies that systematically favor domestic champions over foreign competitors (National Bureau of Statistics of China, 2022). The Chinese government's control over internet governance through the Great Firewall represents perhaps the most extensive national system of digital sovereignty, creating a parallel technological universe that operates according to Beijing's political and ideological parameters (Creemers, 2020). In critical sectors like 5G and semiconductors, China has combined state subsidies with intellectual property acquisition strategies to build domestic capabilities, though with mixed success in areas where it remains dependent on foreign technology, as evidenced by recent U.S. export controls on advanced chips (U.S. Department of Commerce, Bureau of Industry and Security, 2022). China's approach reflects its broader strategic philosophy of “indigenous innovation”, which views technological autonomy as inseparable from national security and the

Communist Party's political control (State Council, 2006). This comprehensive, state-led model shows how technological sovereignty can become an all-encompassing national project when pursued by a government with centralized economic planning capabilities and a long-term strategic horizon.

The United States maintains a more market-driven approach to technological sovereignty, though one that has become increasingly interventionist in response to Chinese competition and global supply chain vulnerabilities. American strategy traditionally relied on the strengths of its private sector innovation ecosystem — the world's leading research universities, venture capital networks, and technology corporations — to maintain global technological leadership (Mazzucato, 2013). However, the perceived threat from China's state-capitalist model has prompted significant departures from this *laissez-faire* tradition. The CHIPS and Science Act of 2022, providing \$52 billion to revitalize domestic semiconductor manufacturing, represents the most substantial U.S. industrial policy intervention in decades, recognizing that market forces alone could not maintain American dominance in this foundational technology (CHIPS and Science Act). Similarly, sweeping export controls on advanced chips and semiconductor equipment to China, implemented in October 2022, demonstrate how Washington increasingly wields its technological advantages as tools of geopolitical competition (U.S. Department of Commerce, Bureau of Industry and Security, 2022). The U.S. approach also includes robust mechanisms to screen foreign investment in critical technologies through the Committee on Foreign Investment in the United States (CFIUS), and legal frameworks like the Export Control Reform Act of 2018 that enhance control over emerging technologies (Export Control Reform Act of 2018). Unlike China's comprehensive state-led model or Europe's regulatory approach, the U.S. maintains its technological sovereignty through a dynamic public-private partnership that leverages government funding and policy to steer, rather than replace, market forces. This hybrid model reflects America's unique position as both the incumbent technological superpower and a nation seeking to respond to unprecedented challenges from rising competitors, particularly China.

The comparative analysis of these approaches reveals several fundamental trends in contemporary technological sovereignty. First, there is growing convergence among major powers in identifying certain foundational technologies — semiconductors, artificial intelligence, quantum computing, biotechnology — as essential to national security and economic resilience. Second, all actors recognize that technological dependence constitutes a critical vulnerability in an era of geopolitical competition, though they respond with different policy tools reflecting their political systems and economic philosophies. Third, the concept of technological sovereignty is developing beyond simple self-sufficiency to encompass control over standards, data flows, intellectual property regimes, and supply chain security.

The pursuit of technological sovereignty has become a universal feature of 21st-century statecraft, with each major power adapting the concept to its particular circumstances while contributing to an emerging international paradigm where technological autonomy equals political and economic independence. For the EU, this means asserting regulatory power to shape global digital markets while building strategic industrial capacities. For

China, it involves comprehensive state-led development of domestic technological capabilities as both an economic and security imperative. For the U.S., maintaining technological sovereignty requires balancing market-driven innovation with strategic interventions to preserve critical advantages. Together, these approaches illustrate how technological sovereignty has moved from the periphery to the center of national strategy, redefining the meaning of power and independence in the digital age. As the technological competition intensifies, the interplay between these different models will likely shape the future of global order, with profound implications for international law, economic governance, and the balance of power. This global trend toward technological sovereignty has found particular resonance in Russia's strategic evolution, where the concept has been systematically incorporated into national security and economic development frameworks. The Russian approach synthesizes elements from these international models while developing distinct characteristics shaped by its unique geopolitical position and economic structure.

#### **4. THE EVOLUTION OF LEGAL REGULATION OF TECHNOLOGICAL SOVEREIGNTY IN RUSSIA: FROM FIRST MENTIONS TO SYSTEMIC STATE POLICY**

The term “technological sovereignty” first appeared in official Russian documents in 1992, notably in a Presidential decree concerning the organization of information gathering and analysis within the context of Russia's political, economic, and technological sovereignty («Questions of the Information and Analytical Center of the Presidential Administration of the Russian Federation» (Rasporjazhenie Prezidenta RF, 1992)). Following the imposition of Western sanctions against Russia, the term “import substitution” has gained widespread use. However, since 2022, “technological sovereignty” has become the dominant term, defining the country's long-term economic development strategy. While import substitution implies finding analogues for foreign products and technologies, technological sovereignty encompasses the creation of domestically competitive technologies and services to foster the innovative development of Russia's infrastructure and achieve independence from foreign companies and states.

Technological sovereignty is increasingly recognized not only as a component of national security but also as a crucial factor determining a country's long-term economic development. This is achieved through the attainment of national development goals, as exemplified by the Russian Federation's national development goals for the period up to 2030 and beyond to 2036. The Presidential Decree outlining these goals specifies the following national objectives:

- a) Preservation of the population, strengthening of health, improvement of well-being, and support for families;
- b) Realization of each individual's potential, development of their talents, and the cultivation of a patriotic and socially responsible citizenry;
- c) A comfortable and safe living environment;
- d) Environmental well-being;

- e) A sustainable and dynamic economy;
- f) Technological leadership;
- g) Digital transformation of state and municipal governance, the economy, and the social sphere (Ukaz Prezidenta RF, 2024a).

The Russian Federation's National Security Strategy (Ukaz Prezidenta RF, 2021) presents a similar, yet broader, understanding of technological sovereignty, encompassing its role within the overall national security framework and as a criterion for evaluating the national science and technology security system. Specifically, paragraph 22 states that «the key factors determining the position and role of the Russian Federation in the world in the long term are becoming a high quality of human potential, the ability to ensure technological leadership, the efficiency of public administration, and the transition of the economy to a new technological basis». In the section on "Economic Security," paragraph 62 establishes that «the transition from exporting primary raw materials and agricultural products to their deep processing, the development of existing and the creation of new high-tech industries and markets, along with the technological upgrading of basic economic sectors and the use of low-carbon technologies, will lead to a change in the structure of the Russian economy, increasing its competitiveness and resilience». Furthermore, paragraph 68 emphasizes that «in the context of the global economy's transition to a new technological basis, leadership in the development of science and technology is becoming one of the key factors in increasing competitiveness and ensuring national security». The overall «goal of scientific and technological development of the Russian Federation is to ensure the technological independence and competitiveness of the country, achieve national development goals, and implement strategic national priorities (paragraph 75)». All this necessitates the integration of political and economic strategies into a unified state policy of technological sovereignty.

Government Decree No. 603 of 15 April 2023 identifies priority areas for technological sovereignty projects and the structural adaptation of the Russian economy. These include first-group projects across 13 priority sectors (aviation industry; automotive industry; railway engineering, etc.) (Postanovlenie Pravitel'stva RF, 2023).

It is important to note that while differences exist in the emphasis between foreign and Russian approaches to the concept of technological sovereignty, stemming from variations in political, economic, and geopolitical contexts, both approaches converge on the understanding of technological sovereignty as a key element of national security and economic growth. The Russian approach, unlike foreign interpretations, emphasizes the integration of technological development within the framework of state policy, prioritizing national control over critical and cross-cutting technologies (Potaptseva, Akberdina & Ponomareva, 2024).

Methodologically, the Concept of Technological Sovereignty (Rasporjazhenie Pravitel'stva RF, 2023) is largely based on established approaches within the science of technological development—namely, the concept of technological paradigm shifts. This concept posits that economic progress occurs through the succession of technological regimes, each characterized by specific technology types and production structures (Shumpeter, 2008).

The Concept for Technological Development until 2030, adopted by Russian Government Directive No. 1315-r dated May 20, 2023, establishes a comprehensive terminology system for national technological policy. Central to this framework is "technological leadership", defined as the superiority of technologies and/or products over foreign counterparts in key parameters—functional, technical, and cost-related. The document introduces "technological sovereignty" as a foundational principle, characterizing it as the nation's capacity to maintain domestic control over critical and cross-cutting technologies, including proprietary R&D capabilities and production infrastructure sufficient to achieve national development goals and safeguard strategic interests. This sovereignty manifests through two primary mechanisms: (1) the research, development, and implementation of designated critical and cross-cutting technologies, and (2) the production of high-tech goods based on these technologies, supported where feasible by sustained international scientific cooperation with partner states.

The policy delineates "critical technologies" as sector-specific technological capabilities essential for manufacturing priority high-tech products and services, deemed vital for economic functionality, socioeconomic objectives, and national defense requirements. Parallel to these are «cross-cutting technologies» — defined as transformative, interdisciplinary technological platforms enabling innovative products/services with economy-wide impacts that either disrupt existing markets or generate entirely new sectors. These cross-cutting technologies are projected to reshape Russia's economic landscape and industrial sectors within a 10-15 year horizon. The conceptual framework positions technological sovereignty not as autarky but as strategic autonomy, balancing domestic capability-building with selective international partnerships in a contested global technological environment. (Rasporjazhenie Pravitel'stva RF, 2023).

The Concept highlights the need for a systemic shift in approaches to the country's scientific and technological development: achieving technological parity while facing limitations in scientific resources, personnel, materials, and finances objectively requires the formation of a system of technological priorities and their consistent "end-to-end" implementation across all stages of the scientific and technological cycle.

Following the adoption of the Russian Government Decree No. 317 of April 18, 2016, "On the Implementation of the National Technological Initiative," and strategic planning documents on the development of the digital economy (Passport, 2019) and the information society (Ukaz Prezidenta RF, 2017), the need to create models for a new environment in the Russian Federation, develop legal norms for new economic sectors, and establish conditions for continuous education to train specialists in demand under current conditions becomes evident (Tihomirov & Nanba 2019).

## **5. TECHNOLOGICAL SOVEREIGNTY AS AN IMPERATIVE OF MODERN STATE DEVELOPMENT**

The urgency of an innovative model for societal development stems from the rapid growth of science and new technologies on socio-economic development over the past 20-30 years. This innovative development model emphasizes the utilization of fundamentally new technologies, the production of high-tech goods, implementing progressive

organizational and managerial solutions in innovation activities, and the intellectualization of all production processes. These technologies have radically and rapidly transformed the structure of the global economy. Inability or delay in a country's structural economic restructuring in accordance with the innovative technological paradigm not only hinders its development but also leads to socio-economic degradation, preventing participation in global economic processes (Pushkareva, 2022).

At the turn of the 20th and 21st centuries, state influence on the formation of a nation's scientific and technological potential intensified, alongside a growing need to stimulate the innovative activity of economic agents and individual citizens. International experience in scientific and technological development shows that the concept of technological dynamism (constant technological revolution) has gained recognition in the governing circles of Western countries. According to this concept, the scientific and technological leadership of developed states – the USA, Japan, and Western Europe – is determined not only by the powerful development of cutting-edge industries but also by the capacity for dynamic and continuous restructuring of all economic sectors to create and diffuse the latest technologies as a key priority of scientific and technological development (Bodrova, 2023).

Technological policy is developing in response to broader reforms aimed at stimulating productivity and economic growth, as well as addressing national challenges (specifically concerning employment, education, and healthcare), and reacting to global issues such as energy security and climate change. New initiatives fostering networking and technological clusters are being implemented. In the context of globalization, this has facilitated the development of these clusters into world-class hubs, rather than geographically dispersed entities. The realization of such objectives promotes successful collaboration between industry and research organizations (Hachaturjan, 2023).

Under these circumstances, technological policy objectives must consider the societal content, defined by society's perception of the fundamental components of the technological system and the criticality of the technologies themselves (Gu, 2024). Technologically advanced countries possessing Critical Technologies (CTs) ensure a stable position on the international stage. For a technology to be considered critical, the selection process must align with political and technological relevance (taking into account priority areas of scientific and technological development), while also being transparent and publicly accessible.

The definition of criticality and approaches to its assessment depend on a country's position and vary from forecast to forecast. Factors influencing the determination of criticality and considered in various forecasts include impacts on competitiveness, the environment, national security, and quality of life, etc. Sometimes, CTs are defined as having the potential for use across many sectors of societal productive activity (general-purpose technologies).

Developed countries consistently prioritize defining key areas for scientific and technological development. A core element of this process is the creation of national lists of critical technologies. These lists are compiled with varying objectives, and the technologies included are selected based on their potential contribution to achieving specific goals. Criteria reflecting both national and sectoral (departmental) specifics are used in

formulating these critical technology (CT) lists. From a certain perspective, such lists serve as a forecast for the country's future technological development, reflecting the most important scientific and technological priorities of national development. The implementation of prioritized state programs for the development of these technologies fulfills the state's coordinating function in high-technology development, based on securing state funding for the development of conceptual, foundational technologies. This state support enables successful competition in high-tech product markets and ensures an adequate level of technological security (Broeders, Cristiano & Kaminska , 2023).

To focus efforts and resources on implementing scientific and technological programs aimed at addressing issues of economic sovereignty and national security, Presidential Decree No. 529 of the Russian Federation, dated 18 June 2024, "On the Approval of Priority Areas of Scientific and Technological Development and the List of the Most Important High-Tech Technologies," was adopted in 2024 (Ukaz Prezidenta RF, 2024b).

This document prioritizes the following areas for scientific and technological development:

1. High-efficiency and resource-saving energy.
2. Preventive and personalized medicine, ensuring healthy longevity.
3. High-productivity and climate-resilient agriculture.
4. Secure acquisition, storage, transmission, and processing of information.
5. Intelligent transport and telecommunication systems, including autonomous vehicles.
6. Strengthening the socio-cultural identity of Russian society and improving its education level.
7. Adaptation to climate change, preservation, and rational use of natural resources.

The decree also distinguishes between critical and cross-cutting technologies. The list of critical technologies comprises 21 items, encompassing areas such as:

- Energy systems;
- Biomedical technologies;
- Agricultural technologies;
- Information technologies;
- Transport systems;
- Social technologies;
- Environmental technologies; and others.

Cross-cutting technologies (8 items) include:

- Synthetic biology and genetic engineering;
- New materials;
- Artificial intelligence;
- Biotechnologies; and others.

Thus, over the past 10-15 years, technological foresight has become an indispensable tool for the Russian Federation in addressing challenges of short- and long-term planning, as well as in making strategic decisions regarding industrial and economic development. The identified critical and cross-cutting technologies possess cross-sectoral significance

and serve as the foundation for technological modernization of production, bringing it to a competitive level.

The current paradigm of rapid qualitative transformations in technological development among leading nations worldwide unequivocally validates the appropriateness of considering innovative high-performance technologies as the driving force for future economic growth. Technological innovations have become the focal point where institutional, economic, technological and organizational factors converge — their optimal combination creates the necessary conditions for effective implementation.

## **6. TECHNOLOGICAL SOVEREIGNTY AS A SYSTEM-FORMING ELEMENT OF STATE SOVEREIGNTY: CONCEPTUAL FOUNDATIONS AND LEGAL MECHANISMS OF IMPLEMENTATION**

Innovation and technological development are complex and multifaceted phenomena, causing the definition of innovative priorities to consider international and regional aspects. This requires the coordination and development of fundamental and applied research, the results of which form the basis of technological development as a whole and have the potential to yield rapid and significant societal benefits. Therefore, state scientific and technological policy, considering the innovative nature of technological changes, must develop the resource and intellectual potential of a specific region in accordance with national priorities for the development of this sphere. Utilizing opportunities for international technological exchange contributes to the accelerated socio-economic development of the country and its regions. International technology transfer plays a significant role in the technological support of socio-economic development (Schot & Steinmueller, 2018).

Socio-economic growth has always been accompanied by technological transformation across all spheres of human productive activity — from the manufacturing sector to lifestyle itself. The level of technological advancement serves as an indicator of a state's development. However, the question of the primacy of the influence of economics and technology on accelerating socio-economic growth remains open.

The extreme complexity of the techno sphere demands a significant increase in the volume of scientific information, necessary not only for its development but also for maintaining its safe operation. Under these conditions, societal needs for the results of scientific research, particularly original developments by domestic scientists, are increasing, thus highlighting the importance of intellectual property protection.

Ensuring conditions for the growth of domestic technological potential and its effective use in the interests of society, considering global experience and innovative priorities in innovation and technological development, aims to effectively implement state scientific and technological policy. This policy focuses on supporting domestic fundamental and applied research, and fostering a national culture within the global information and technological space.

Thus, technological sovereignty of the state, as a component of its overall sovereignty, should be based on three fundamental principles: 1) resilience; 2) development of a competitive economic potential; and 3) ensuring national autonomy.

## ***6.1. Resilience***

The socioeconomic development of states in the current geopolitical environment is increasingly determined not only by domestic factors but also by the imperative to counter external threats, including unprecedented sanctions pressure from unfriendly nations. For the Russian Federation, this reality has brought the issue of technological sovereignty to the forefront of national security considerations. Sanctions targeting Russia's access to critical technologies, international payment systems, and high-tech supplies have exposed the vulnerabilities inherent in economic models dependent on global value chains. In this context, national economic resilience must be built upon three fundamental pillars: reducing critical dependence on foreign technologies, components, and financial instruments that may serve as tools of political pressure; developing adaptive mechanisms to swiftly respond to new restrictive measures through diversification of foreign economic ties and creation of alternative logistical and financial channels; and establishing closed technological cycles in strategic industries that ensure basic economic needs and national defense capabilities.

These challenges intersect with global concerns regarding anthropogenic environmental impact, resource depletion, and climate change. Neglecting sustainable development principles exacerbates technological dependence in the long term, as resource-dependent economies become more vulnerable to global market fluctuations, while the absence of green technologies leads to increased environmental costs and restricted access to markets with stringent ecological standards. Consequently, building economic resilience under sanctions requires an integrated approach combining technological self-sufficiency in critical sectors, accelerated transition to sustainable development models, and development of legal mechanisms to mitigate risks of further external pressure. The absence of such measures inevitably increases dependence on external factors, limiting state sovereignty in key political and economic decision-making.

## ***6.2. Developing a Competitive Economic Potential***

Amidst geopolitical instability and sanctions pressure, developing competitive economic potential has become strategically crucial for ensuring technological sovereignty. As Michael Porter correctly observed, contemporary global economic competitiveness stems not from natural resources or cheap labor, but from an economic system's capacity for continuous innovation-driven modernization (Porter, 2008) — a principle of particular relevance for Russia in the current technological confrontation.

The formation of competitive economic potential rests upon several key directions: development of high-tech sectors through creation of innovative products, modernization of production processes, and implementation of advanced management technologies; stimulation of innovation through strengthening scientific-technical capabilities, supporting research and development, and creating favorable conditions for tech startups; and establishment of effective innovation infrastructure, including venture financing, technological clusters, and science-business cooperation.

Of particular importance under sanctions is the development of import-independent technologies in strategic sectors such as microelectronics, machine tool manufacturing,

pharmaceuticals, IT, and telecommunications. Global experience shows that successful technological development requires continuous modernization of production capacity, human capital development, effective technology commercialization systems, and favorable investment climate — all of which must be adapted to Russia's unique geopolitical and economic circumstances while maintaining a focus on achieving technological sovereignty as a fundamental component of national security and sustainable development.

### ***6.3. Ensuring National Autonomy***

In the current era of intensified global technological competition and expanding sanction regimes, the capacity to ensure national autonomy in scientific and technological development has emerged as a critical determinant of genuine state sovereignty. This imperative necessitates the development of a comprehensive technological model capable of sustaining economic stability and preserving political independence amidst growing external pressures. The contemporary conceptualization of technological autonomy incorporates three essential dimensions that collectively form a framework for sovereign technological development.

First, strategic self-reliance makes up the foundational element, requiring domestic capacity to fulfill critical technological needs across vital sectors, including core industrial technologies, robust information security systems, advanced defense technologies, and essential medical and pharmaceutical innovations. Second, a flexible model of technological sovereignty must be cultivated through systematic development of indigenous scientific potential, careful diversification of international partnerships, and the creation of redundant technological solutions as safeguards against supply chain disruptions. Third, maintaining an optimal equilibrium between autonomy and cooperation demands strategic prioritization of collaborations with reliable partner states, formation of alternative technological alliances, and selective participation in mutually beneficial international initiatives.

The establishment of an effective national innovation system represents a crucial institutional prerequisite for achieving technological autonomy, comprising four interdependent components: a competitive research and development infrastructure, efficient mechanisms for commercializing scientific breakthroughs, modernized educational systems aligned with technological priorities, and flexible frameworks for public-private collaboration. Empirical evidence confirms that a nation's degree of technological self-sufficiency directly correlates with its substantive sovereignty in contemporary international relations. Importantly, technological autonomy should not be misconstrued as complete autarky, but as the strategic capacity to maintain critical technological competencies while engaging in selective international cooperation.

From a legal perspective, the realization of technological autonomy requires comprehensive regulatory modernization, including refinement of legislation governing scientific and technological policy, implementation of specialized legal regimes for protecting critical technologies, enhancement of intellectual property safeguards, and institutionalization of systematic technological forecasting mechanisms. In the present geopolitical context, technological autonomy has transcended its traditional economic dimensions to become an indispensable attribute of state sovereignty, serving simultaneously as a shield

against external coercion and an instrument for preserving national strategic autonomy in an increasingly contested international order.

Technological sovereignty is a complex, multifaceted concept demanding a balanced interplay of economic, technological, and legal mechanisms to ensure national security and sustainable development amidst global challenges. Effective implementation requires comprehensive legal regulation. In the Russian Federation, a significant step in this direction was the adoption of the Federal Law «On Technological Policy in the Russian Federation» (Federal'nyj zakon, 2024) on 28 December 2024, which lays the legal foundation for ensuring the country's technological sovereignty.

This law serves as a system-forming normative act, establishing the legal framework for the realization of Russia's technological sovereignty. It introduces a comprehensive mechanism for state governance in the sphere of technological development, particularly relevant in the context of contemporary geopolitical challenges and sanctions pressure. Of significant interest are the provisions concerning critical (Article 10) and cross-cutting (Article 11) technologies, which define a list of strategic directions for technological development. The institute of national projects for technological leadership (Chapter 4) and projects for the development of cross-cutting technologies (Chapter 5) create a legal basis for concentrating resources on priority areas. A distinguishing feature of the law is the detailed regulation of the powers of government bodies at different levels (Articles 7-8); the functions of organizations with state participation (Article 9); mechanisms for technological cooperation (Article 16); and measures to stimulate innovation (Articles 22-24). The law also modernizes the legal status of key state corporations («Rosatom», «Roscosmos»), underscoring their role in ensuring technological sovereignty.

From a methodological perspective, this law exemplifies comprehensive legal regulation of technological development, where state governance measures are combined with mechanisms of public-private partnership. Therefore, the law establishes the legal conditions for the realization of technological sovereignty as an integral component of state sovereignty in the modern era.

## 7. CONCLUSION

The research conducted allows for a number of key conclusions that are crucial for understanding the contemporary transformation of the concept of state sovereignty. At the beginning of the 21st century, technological progress ceased to be solely a factor of economic growth, transforming into a key element of national security and state sovereignty. The global digital transformation has led to the formation of a new paradigm of world order, where technological dominance becomes the basis of geopolitical influence, and the traditional framework of state sovereignty expands to include a country's ability to independently determine the trajectory of its technological development.

Analysis of the current geopolitical situation, particularly the sanctions pressure on Russia, clearly demonstrated the vulnerability of states dependent on external technological chains. Restrictions on the supply of high-tech products and disconnection from international payment systems have shown how technological dependence can be used

as a tool of political and economic coercion. Under these conditions, technological sovereignty ceases to be solely an economic category, transforming into a fundamental aspect of national security.

The study of the classical doctrine of state sovereignty confirmed that its key characteristics – unity, indivisibility, and inalienability – acquire new meaning in the digital age. The territorial component of sovereignty is supplemented by a technological dimension, where a violation of sovereignty should be considered not only direct military intervention but also forms of technological coercion.

The Russian Federation is taking systematic measures to form the legal basis for technological sovereignty, which is reflected both in normative acts of a programmatic nature and in documents containing specific substantive legal norms. Thus, the adopted documents create a comprehensive system of legal regulation, including the definition of critical and cross-cutting technologies, mechanisms of state governance, and stimulation of innovative activity. The Federal Law "On Technological Policy", adopted in 2024, represents a significant step in creating an effective legal mechanism for ensuring technological sovereignty. Its significance lies in the detailed regulation of the powers of government bodies, the functions of organizations with state participation, and measures to stimulate innovative activity. However, much will depend on the proper implementation of the provisions and their specification in subordinate acts of executive authorities.

Of particular importance is the consolidation in regulatory acts of three fundamental pillars of technological sovereignty: resilience to external threats, ensuring economic competitiveness, and guaranteeing state independence. As the analysis showed, it is the combination of these elements that allows for the preservation of sovereignty in the context of technological rivalry among global centers of power.

In general, the research confirms that in contemporary conditions, technological sovereignty is becoming an integral component and material basis of state sovereignty. Ensuring it requires a balanced approach, combining the development of one's own scientific and technological potential with selective international cooperation. Further research should be directed towards developing criteria for assessing the level of technological sovereignty and improving mechanisms for its legal protection in the context of global technological competition.

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