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INTERNATIONAL EXPERIENCE IN IMPLEMENTING ECONOMIC DEVELOPMENT AND RECOVERY STRATEGIES: SECURITY ASPECTS OF SOVEREIGNIZATION OF POLICY IN THE CONDITIONS OF TECHNOLOGICAL TRANSFORMATIONS

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**МІЖНАРОДНИЙ ДОСВІД ВПРОВАДЖЕННЯ СТРАТЕГІЙ ЕКОНОМІЧНОГО РОЗВИТКУ І
ВІДНОВЛЕННЯ: БЕЗПЕКОВІ АСПЕКТИ СУВЕРЕНІТИЗАЦІЇ ПОЛІТИКИ В УМОВАХ
ТЕХНОЛОГІЧНИХ ТРАНСФОРМАЦІЙ**

The study solves an important scientific problem of identifying nuanced differences between concepts of technological development based on the phenomena of independence, sovereignty, and autonomy, which will allow creating a more accurate theoretical framework for analyzing state responses to technological challenges in the context of implementing a strategic policy of economic recovery and reconstruction. The presented document contains a comprehensive analysis of four economic recovery strategies developed on the basis of key concepts of technological governance. The study is based on a detailed analysis of the theoretical foundations of technological

sovereignty, independence, self-reliance and autonomy. The Digital Sovereignty Strategy focuses on creating a comprehensive system of state control over technological processes through the development of a regulatory framework and institutional mechanisms. Key elements are the creation of a national digital sovereignty agency, comprehensive legislation and a state fund with a capital of 2% of GDP. The Technological Independence Strategy aims to systematically reduce dependence on foreign technological suppliers through the diversification of supply chains and the development of national alternatives. The main components include a comprehensive audit of technological dependencies, the implementation of the principle of multiple suppliers and import substitution programs. The Technological Independence Strategy is focused on building comprehensive internal capabilities for autonomous technological development. The strategy envisages a large-scale education reform, the creation of 50 research centers and an increase in R&D spending to 3% of GDP. The "Technological Autonomy" strategy ensures democratic control over technological choices by creating mechanisms for public participation in technological decision-making. Key elements include a National Council for Technological Ethics, mandatory technological impact assessments and digital literacy programs. Each strategy is designed for 5–10 years of implementation and envisages the creation of 300,000 to 800,000 new jobs. Expected economic results include an increase in GDP by 15%, achieving technological leadership in key sectors and the formation of sustainable national technological ecosystems. The study demonstrates that the most effective approach is to combine elements of different strategies in accordance with specific national conditions and geopolitical context. All strategies are aimed at ensuring long-term technological competitiveness and economic security. The article was prepared as part of the research work 0123U102061 "International mechanisms for providing resources of strategic importance to increase the defense capability of Ukraine."

Метою даного дослідження є визначення нюансованих відмінностей між концепціями технологічного розвитку, що базуються на феноменах незалежності, суверенітету і автономії, що дозволить створювати більш точні теоретичні рамки для аналізу державних відповідей на технологічні виклики в умовах реалізації стратегічної політики економічного відновлення та відбудови. Представлений документ містить комплексний аналіз чотирьох стратегій економічного відновлення, розроблених на основі ключових концепцій технологічного управління. Дослідження базується на детальному аналізі теоретичних основ технологічного суверенітету, незалежності, самостійності та автономії. Стратегія "Цифровий Суверенітет" фокусується на створенні всеосяжної системи державного контролю над технологічними процесами через розвиток регулятивних рамок та інституційних механізмів. Ключовими елементами є створення національного агентства цифрового суверенітету, комплексне законодавство та державний фонд з капіталом 2% ВВП. Стратегія "Технологічна Незалежність" спрямована на системне зменшення залежності від іноземних технологічних постачальників через диверсифікацію ланцюгів постачання та розвиток національних альтернатив. Основні компоненти включають комплексний аудит технологічних залежностей, впровадження принципу множинних постачальників та програми імпортозаміщення. Стратегія "Технологічна Самостійність" орієнтована на побудову комплексних внутрішніх можливостей для автономного технологічного розвитку. Стратегія передбачає масштабну реформу освіти, створення 50 науково-дослідних центрів та збільшення витрат на НДДКР до 3% ВВП. Стратегія "Технологічна Автономія" забезпечує демократичний контроль над технологічними виборами через створення механізмів громадської участі у прийнятті технологічних рішень. Ключові елементи включають Національну раду з технологічної етики, обов'язкову оцінку технологічного впливу та програми цифрової грамотності. Кожна стратегія розрахована на 5–10 років впровадження та передбачає створення від 300,000 до 800,000 нових робочих місць. Очікувані економічні результати включають збільшення ВВП на 15%, досягнення технологічного лідерства у ключових секторах та формування стійких національних технологічних екосистем. Дослідження демонструє, що найбільш ефективним підходом є комбінування елементів різних стратегій відповідно до специфічних національних умов та геополітичного контексту. Всі стратегії спрямовані на забезпечення довгострокової технологічної конкурентоспроможності та економічної безпеки. Стаття підготовлена в рамках виконання науково-дослідної роботи 0123U102061 "Міжнародні механізми забезпечення ресурсами стратегічного значення для підвищення обороноздатності України".

Key words: world order, geopolitics, technoglobalism, conflicts, challenges, threats, economic security, economic sovereignty, technological sovereignty, resources for development, strategic interest, economic interest, development strategy, recovery strategy, reconstruction strategy, infrastructure, champion companies, control, intervention, institutions, AI.

Ключові слова: світовий порядок, геополітика, техноглобалізм, конфлікти, виклики, загрози, економічна безпека, економічний суверенітет, технологічний суверенітет, ресурси для розвитку, стратегічний інтерес, економічний інтерес, стратегія розвитку, стратегія відновлення, стратегія відбудови, інфраструктура, компанії-чемпіони, інноваційна система, контроль, втручання, інститути, ШІ.

INTRODUCTION

The contemporary geopolitical landscape has witnessed an unprecedented emphasis on technological capabilities as determinants of national power and

strategic autonomy. Within this context, academic and policy discourse has increasingly employed a constellation of related yet distinct concepts to describe various aspects of technological control and self-

determination. Four terms have emerged as particularly prominent in English-language research: technological sovereignty, technological independence, technological self-reliance, and technological autonomy. While these concepts are frequently used interchangeably in academic literature, each carries distinct conceptual implications and theoretical foundations that warrant careful examination.

The conflation of these terms reflects both the evolving nature of technological governance and the interdisciplinary character of contemporary research on technology policy. Scholars from fields ranging from international relations and political economy to science and technology studies have contributed to this discourse, often bringing discipline-specific interpretations to seemingly universal concepts. This conceptual proliferation has created a rich but sometimes confusing terminological landscape where precision of meaning becomes crucial for both theoretical development and practical policy formulation. Understanding the nuanced differences between these concepts is essential for several reasons. First, it enables more precise theoretical frameworks for analyzing state responses to technological challenges. Second, it facilitates clearer communication between researchers working across different disciplinary boundaries. Third, it provides policymakers with more sophisticated analytical tools for designing and implementing technology policies. Finally, it contributes to a more nuanced understanding of how different nations conceptualize and pursue technological self-determination in an increasingly interconnected world.

THE REVIEW OF THE LITERATURE

Author teams led by Bulatova O. [1; 2; 3; 15; 16], Duginets G. [4], Lukyanenko D. [5], Panchenko V. [6; 7; 8; 9; 10; 13; 22], Yatsenko O. [14] investigated the features of implementing international economic development strategies, taking into account threats to economic security in the context of global conflicts and structural imbalances that provoke the processes of deglobalization or the so-called slobalization.

Huang C., & Soete L. [19]. Edler J., Blind K., Kroll H. & Schubert T. [17]. March C. & Schieferdecker I. [21], Roberts H., Cows J., Morley J., Taddeo M., Wang V. & Floridi L. [24] analyzed the phenomenon of technological sovereignty as a key imperative of economic development policy. The challenges to world order in the face of military threat are noted in the works of Farrell H. & Newman A. L. [18], Kirshner J. [20], Schwarzer D. [25], Stamegna M., Bonaiuti C., Maranzano P. & Pianta M. [26], Streeck W. [27].

THE PURPOSE OF THE ARTICLE

Метою даного дослідження є визначення нюансованих відмінностей між концепціями технологічного розвитку, що базуються на феноменах незалежності, суверенітету і автономії, що дозволить створювати більш точні теоретичні рамки для аналізу державних відповідей на технологічні виклики в умовах реалізації стратегічної політики економічного відновлення та відбудови.

RESEARCH RESULTS

Technological sovereignty represents perhaps the most comprehensive and politically charged of the four concepts under examination. Rooted in traditional notions of state sovereignty, technological sovereignty encompasses the state's capacity to exercise ultimate authority over technological systems, infrastructure, and development within its territorial boundaries. This concept extends beyond mere technological capability to include the legal, regulatory, and institutional frameworks necessary to maintain control over technological domains. The theoretical foundations of technological sovereignty draw heavily from Westphalian concepts of state sovereignty while adapting to the unique characteristics of contemporary technological systems. Unlike traditional sovereignty, which primarily concerned territorial control and political authority, technological sovereignty must grapple with the inherently transnational nature of modern technology. Digital networks, global supply chains, and international standards create technological interdependencies that challenge conventional notions of sovereign control. European scholarship has been particularly influential in developing the concept of technological sovereignty, with the European Union's digital sovereignty initiatives providing concrete examples of how this concept translates into policy practice. The EU's efforts to develop autonomous capabilities in areas such as cloud computing, artificial intelligence, and semiconductor manufacturing reflect an understanding of technological sovereignty that emphasizes both defensive and offensive capabilities. Defensive aspects include protecting critical technological infrastructure from foreign interference, while offensive capabilities involve the capacity to shape global technological standards and norms. The concept of technological sovereignty also encompasses what might be termed "technological jurisprudence" — the ability to establish and enforce rules governing technological systems. This includes data protection regulations, cybersecurity standards, and technology transfer restrictions. The extraterritorial application of regulations such as the General Data Protection Regulation (GDPR) demonstrates how technological sovereignty can extend beyond national boundaries, creating global regulatory frameworks that reflect the sovereign preferences of powerful technological actors. Contemporary manifestations of technological sovereignty can be observed in national policies aimed at reducing dependence on foreign technology suppliers, developing indigenous technological capabilities, and establishing regulatory frameworks that prioritize national interests. China's pursuit of technological self-sufficiency in semiconductors, the United States' restrictions on technology transfers to strategic competitors, and India's promotion of domestic technology champions all reflect different approaches to achieving technological sovereignty.

Technological independence represents a more narrowly focused concept that emphasizes the elimination of external dependencies in critical technological domains. Unlike technological sovereignty, which encompasses broader questions of control and authority, technological independence specifically addresses the capacity to function without reliance on foreign technological inputs,

systems, or expertise. This concept is particularly relevant in discussions of critical infrastructure, defense technologies, and strategic industries where external dependencies may create vulnerabilities.

The theoretical underpinnings of technological independence draw from economic theories of dependency and strategic studies literature on vulnerability and resilience. Dependency theory's emphasis on the structural disadvantages faced by peripheral economies in their relationships with core economies provides a framework for understanding how technological dependencies can perpetuate asymmetric power relationships. From this perspective, technological independence becomes not merely a policy preference but a prerequisite for genuine economic and political autonomy.

Strategic studies literature contributes another dimension to understanding technological independence through its focus on vulnerability assessment and risk management. Technologies are evaluated not only for their economic or social benefits but also for their potential to create strategic dependencies that adversaries might exploit. This perspective has become increasingly prominent in discussions of critical supply chains, where the COVID-19 pandemic and various trade disputes have highlighted the risks associated with excessive reliance on single sources or geographically concentrated suppliers.

The operationalization of technological independence often involves policies aimed at diversifying supply chains, developing domestic alternatives to foreign technologies, and creating strategic reserves of critical technological components. South Korea's K-Semiconductor Belt project exemplifies this approach, seeking to create a comprehensive domestic semiconductor ecosystem that reduces dependence on foreign suppliers while strengthening the country's position in global technology markets.

However, technological independence faces significant practical limitations in an interconnected world. The complexity of modern technological systems means that complete independence is often economically inefficient or technically impossible. Instead, countries typically pursue selective independence in areas deemed most critical to national security or economic competitiveness while accepting interdependence in less sensitive domains. This selective approach requires sophisticated analysis of technological dependencies and their strategic implications.

Technological self-reliance emphasizes the development of indigenous technological capabilities and the capacity for autonomous innovation. While closely related to technological independence, self-reliance focuses more on building endogenous capabilities rather than simply eliminating external dependencies. This concept encompasses not only the ability to produce existing technologies domestically but also the capacity to innovate and adapt technologies to meet specific national needs and circumstances.

The conceptual foundation of technological self-reliance draws from development economics literature on endogenous growth and innovation systems. Endogenous growth theory emphasizes the role of knowledge accumulation, research and development, and human capital

formation in driving long-term economic growth. From this perspective, technological self-reliance becomes essential for sustainable development and competitive advantage in knowledge-based economies.

Innovation systems theory provides another important theoretical foundation for understanding technological self-reliance. This approach emphasizes the importance of institutional frameworks, linkages between different actors, and the accumulation of technological capabilities over time. Technological self-reliance, from this perspective, requires not only technical capabilities but also the institutional infrastructure necessary to support continuous innovation and adaptation.

India's approach to technological development provides a compelling case study of technological self-reliance in practice. The country's "Atmanirbhar Bharat" (Self-Reliant India) initiative explicitly emphasizes the development of domestic technological capabilities across various sectors. This approach combines import substitution policies with investments in research and development, education, and industrial infrastructure. The initiative recognizes that technological self-reliance requires a comprehensive ecosystem of capabilities rather than simply the ability to produce specific technologies.

Technological autonomy represents perhaps the most nuanced of the four concepts, emphasizing the capacity for independent decision-making regarding technological choices and development paths. Unlike the other concepts, which focus primarily on capabilities and dependencies, technological autonomy centers on agency and the ability to make autonomous choices about technological development and deployment. This concept recognizes that technological decisions are not merely technical but also involve values, priorities, and strategic considerations that should reflect national preferences and circumstances.

The theoretical foundation of technological autonomy draws from political theory discussions of autonomy and self-determination, as well as science and technology studies literature on technological choice and social shaping of technology. Political theory's emphasis on autonomy as the capacity for self-governance provides a framework for understanding how technological choices relate to broader questions of democratic governance and self-determination.

Science and technology studies literature contributes important insights into how technological choices are shaped by social, political, and economic factors. The social construction of technology approach emphasizes that technological development is not predetermined but involves choices between alternative possibilities. From this perspective, technological autonomy becomes the capacity to participate meaningfully in shaping technological development rather than simply accepting technological imperatives determined elsewhere.

We have proposed the following strategies for economic recovery based on the above-mentioned technological concepts.

Strategy "Digital Sovereignty" (based on the concept of technological sovereignty). Tentative title "National Platform of Digital Sovereignty for Economic Recovery." Creating a comprehensive ecosystem of technological

control, which will provide the state with the opportunity to independently determine the directions of technological development and protect critical digital infrastructure. The strategy is aimed at achieving full control over key technological processes through the development of regulatory frameworks and institutional mechanisms. Key components of the strategy: (1) regulatory block: creation of a national agency of digital sovereignty with the authority to control all critical technological systems; development of comprehensive legislation on digital sovereignty, including requirements for data and technology localization; implementation of a technological audit system for all critical infrastructure facilities; creation of national cybersecurity standards with mandatory compliance for all public and private organizations; (2) institutional block: formation of an interdepartmental council on technological sovereignty under the leadership of the Prime Minister; creation of specialized centers of competence in the fields of AI, cybersecurity, and digital technologies; development of a system of public-private partnership for technological projects of strategic importance; introduction of mandatory certification of technological solutions for critical infrastructure; (3) economic block: creation of a state fund for technological sovereignty with a capital of 2% of GDP; introduction of tax incentives for companies using national technological solutions; development of import substitution programs in critical technological areas; creation of special economic zones for the development of sovereign technologies. The expected results of this strategy are focused on: achieving 80% independence in critical technological areas within 5 years; creation of 500,000 new jobs in high-tech sectors; increase in GDP by 15% due to the development of its own technological capabilities; formation of a sustainable national technological ecosystem.

The "Technological Independence" strategy (based on the concept of technological independence) can be called the "Program for Diversification and Strategic Independence of Critical Technologies." Its goal is to systematically reduce dependence on foreign technological suppliers in critical areas through diversification of supply chains and development of alternative technological solutions. The strategy focuses on identifying and eliminating critical technological vulnerabilities. Key components of the strategy: (1) analytical block: conducting a comprehensive audit of technological dependencies in all sectors of the economy; creating a national map of critical technological dependencies with a ranking by risk level; developing an early warning system for potential disruptions in technological supply chains; monitoring geopolitical risks and their impact on technological security; (2) diversification block: implementing the principle of "multiple suppliers" for all critical technologies; developing strategic partnerships with technologically advanced countries; creating regional technological alliances to reduce dependence on dominant suppliers; developing a national system of strategic technological reserves; (3) import substitution: identification of priority technologies for import substitution based on the criterion of strategic importance; creation of targeted programs

to support domestic producers of technological solutions; development of a system of public procurement with preferences for national suppliers; stimulation of technology transfer from international to national companies; (4) financial block: creation of a fund of technological independence to finance critical projects; introduction of a system of state guarantees for investments in technological substitution; development of risk financing mechanisms for startups in the field of critical technologies; tax incentives for companies that reduce technological dependence. Expected results include: reduction of critical technological dependence by 60% within 7 years; creation of 300,000 new jobs in import substitution sectors; increase of the share of national technologies in critical infrastructure to 70%; formation of a sustainable technological security system.

Strategy "Technological Independence" (based on the concept of technological independence) "National Program for Technological Leadership and Innovative Development". Its goal is to build comprehensive internal capabilities for the development, production and improvement of advanced technologies. The strategy is aimed at creating a self-sufficient innovation ecosystem capable of autonomous technological development and global competition. Key components of the strategy: (1) educational and scientific block: large-scale reform of higher education with a focus on STEM disciplines and digital technologies; creation of 50 new world-class research centers in priority technological areas; implementation of scholarship programs for the best students of technical specialties; development of a system of continuous learning for employees of technological sectors; creation of a network of technological universities with direct links with industry; (2) innovation block: creation of a national system of technological incubators and accelerators; development of a network of technoparks in all regions of the country; implementation of programs to support startups in the field of advanced technologies; creation of public-private laboratories for joint research; development of a system for protecting intellectual property of national origin; (3) industrial block: modernization of industrial infrastructure with the introduction of Industry 4.0 technologies; creation of national champions in key technological sectors; development of a subcontracting system to attract small and medium-sized enterprises to technological chains; implementation of programs for the digitalization of traditional industries; creation of specialized production clusters; (4) financial block: increase of state spending on R&D to 3% of GDP; creation of a national venture fund to finance technological startups; introduction of tax incentives for companies investing in R&D; development of a grant financing system for university research; creation of mechanisms for co-financing private-public technological projects. Expected results include: achieving technological leadership in 5 key sectors within 10 years; creation of 800,000 new high-productivity jobs; increasing the share of high-tech exports to 40% of total exports; entering the top 10 countries in the world according to the innovation index.

Strategy "Technological Autonomy" (based on the concept of technological autonomy) "Democratic technological platform: citizen control over technological development". Its goal is to ensure the ability of society to independently make decisions on technological choices and development directions in accordance with national values and priorities. The strategy is aimed at creating mechanisms for democratic control over technological development and ensuring that technological decisions comply with public interests. Key components of the strategy: (1) institutional block: creation of a National Council on Technological Ethics with the participation of public representatives; introduction of a mandatory technological impact assessment for all large technological projects; creation of a system of public hearings on technological development issues; development of the institute of a technological ombudsman to protect citizens' rights; introduction of mechanisms for public examination of technological solutions; (2) regulatory block: development of ethical standards for the development and implementation of AI systems; creation of national principles of responsible technological development; introduction of transparency requirements for algorithmic decision-making systems; development of a technology certification system based on ethical and security principles; creation of mechanisms for public control over the use of personal data; (3) educational and awareness-raising block: implementation of digital literacy programs for all age groups; creation of a system for public information about technological risks and opportunities; development of a network of technological education centers for citizens; introduction of technological ethics courses in secondary education institutions; creation of platforms for public discussion of technological issues; (4) democratic block: implementation of technological referendum mechanisms for critically important decisions; creation of public technological councils at the local level; development of a participatory budgeting system for technological projects; introduction of open governance principles in the technological sphere; creation of mechanisms for public monitoring of the implementation of technological programs; (5) international block: active participation in the development of international standards of technological ethics; creation of coalitions of countries to promote democratic principles in technologies; development of diplomatic initiatives on ethical AI; participation in international organizations on technological governance; promoting the national model of technological autonomy at the international level. The expected results are designed to: achieve a 90% level of public trust in the technological decisions of the authorities; create a model of democratic technological governance for international application; form a technologically literate society with a high level of digital culture; ensure that all technological decisions comply with national values and interests.

CONCLUSIONS

The study solves an important scientific problem of identifying nuanced differences between concepts of technological development based on the phenomena of independence, sovereignty, and autonomy, which will allow creating a more accurate theoretical framework for

analyzing state responses to technological challenges in the context of implementing a strategic policy of economic recovery and reconstruction. The increasing importance of digital technologies poses new challenges for all four concepts examined in this analysis. Digital technologies are characterized by network effects, platform dynamics, and global standards that create new forms of technological interdependence. Traditional approaches to technological independence or self-reliance may be less applicable in digital domains where value creation depends on network participation and data flows.

Artificial intelligence presents particular challenges for technological autonomy and sovereignty. AI systems often require access to large datasets and computing resources that may be controlled by foreign entities. The development of AI systems also involves algorithmic choices that embed particular values and assumptions about how decisions should be made. Ensuring technological autonomy in AI development requires not only technical capabilities but also the capacity to make independent choices about how AI systems should be designed and deployed.

The global nature of contemporary technological challenges, such as climate change and cybersecurity, also complicates efforts to achieve technological independence or self-reliance. These challenges require international cooperation and coordination, making complete technological independence potentially counterproductive. The challenge for policymakers is to balance the desire for technological self-determination with the need for international cooperation in addressing global challenges.

The four proposed economic recovery strategies reflect different approaches to technological development, each with its own advantages and specific applications. The digital sovereignty strategy is best suited for countries seeking maximum control over technological processes. The technological independence strategy is effective in cases of critical dependencies on external suppliers. The technological self-reliance strategy is optimal for long-term innovative development. The technological autonomy strategy ensures democratic control over technological choices. The practical implementation of these strategies requires taking into account specific national conditions, resource capabilities, and geopolitical context. A combined approach that combines elements of different strategies according to the specific needs and capabilities of the country may be the most effective.

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