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INNOVATIVE MODELS OF PUBLIC-PRIVATE ALLIANCES IN INTERNATIONAL TRADE IN DUAL-USE GOODS: PATHS TO GLOBAL LEADERSHIP

The purpose of this article is to highlight innovative models of public-private alliances in international trade in dual-use goods, which are characterized by heightened geopolitical risks and technological interdependencies, involving an analysis of mechanisms for ensuring compliance, innovation, and sustainability with prospects for integration into extensive networks of interdependent global actors. Preserving technological sovereignty is a prerequisite for comprehensive trade security: sovereignty enables, with timely implementation of adaptive transformation policies, the assurance of national competitiveness in dual-use sectors. The study analyzes the interrelations between trade security, technological leadership, and global economic integration through the lens of critical political economy. The paper examines the evolution of conceptual approaches to understanding public-private alliances in the context of globalization, when traditional state control is giving way to complex network structures involving non-state actors such as transnational corporations and technology start-ups. The main focus is on analyzing two key paradigms of partnerships in trade in dual-use goods – the control paradigm and the innovation paradigm – which have different impacts on the trade sovereignty of participating countries. The study demonstrates how the technological revolution and the formation of the technosphere create new challenges for traditional mechanisms of state regulation of trade. Particular attention is paid to Ukraine's experience during the war, which has been a catalyst for the formation of a "national ecosystem of military-technological champions" that combines defense needs with long-term economic modernization goals through dual-use innovation. In parallel, the American "champions" strategy is analyzed as a response to strategic competition with China and the need to restore lost technological competencies in dual-use areas. The study substantiates the concept of "strategic interdependence," which involves the formation of networks of leading companies from democratic countries to counter authoritarian challenges while preserving the benefits of globalization through "friendly reshoring." The study allows us to draw key conclusions about the transformation of the global trade architecture and its impact on national technological sovereignty in the context of the transformation of the world order.

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Keywords: *world order, global leadership, strategic interdependence, strategic adaptation, public-private alliances, geo-technological alliances, national ecosystem of military-technological champions, R&D ecosystem, technological sovereignty, technosphere, trade security, WTO, export control, sanctions, dual-use goods, biotechnology, cybersecurity, AI, blockchain, Made in China 2025, CHIPS, post-war recovery, AGTAF*

JEL Classification *F13, F52, F55, 019, O32, O33, O38*

ІННОВАЦІЙНІ МОДЕЛІ ДЕРЖАВНО-ПРИВАТНИХ АЛЬЯНСІВ У МІЖНАРОДНІЙ ТОРГІВЛІ ТОВАРАМИ ПОДВІЙНОГО ПРИЗНАЧЕННЯ: ШЛЯХИ ДО ГЛОБАЛЬНОГО ЛІДЕРСТВА

Мета статті полягає у висвітленні інноваційних моделей державно-приватних альянсів у міжнародній торгівлі товарами подвійного призначення, що характеризуються загостренням геополітичних ризиків та технологічними взаємозалежностями, що передбачає аналіз механізмів забезпечення комплаєнсу, інновацій та стійкості з перспективами інтеграції в розгалужені мережі взаємозалежних глобальних акторів. Збереження технологічного суверенітету виступає передумовою можливості всебічного забезпечення торгівельної безпеки: суверенітет дає можливість, за своєчасно реалізованої політики адаптивних трансформацій, забезпечувати національну конкурентоспроможність у секторах подвійного призначення. Дослідження присвячене аналізу взаємозв'язків між торгівельною безпекою, технологічним лідерством та глобальною економічною інтеграцією крізь призму критичної політичної економії. У роботі розглядається еволюція концептуальних підходів до розуміння державно-приватних альянсів в умовах глобалізації, коли традиційний державний контроль поступається місцем складним мережевим структурам за участі недержавних акторів, таких як транснаціональні корпорації та технологічні стартапи. Основна увага приділяється аналізу двох ключових парадигм партнерств у торгівлі товарами подвійного призначення – парадигми контролю та парадигми інновацій, які по-різному впливають на торгівельний суверенітет країн-учасниць. Дослідження демонструє, як технологічна революція та формування техносфери створюють нові виклики для традиційних механізмів державного регулювання торгівлі. Особливу увагу приділено українському досвіду воєнного періоду, який став каталізатором для формування «національної екосистеми військово-технологічних чемпіонів», що поєднує оборонні потреби з довгостроковими цілями економічної модернізації через інновації подвійного призначення. Паралельно аналізується американська стратегія «чемпіонів» як відповідь на стратегічну конкуренцію з Китаєм та необхідність відновлення втрачених технологічних компетенцій у сферах подвійного призначення. Дослідження обґрунтовує концепцію «стратегічної взаємозалежності», яка передбачає формування мереж провідних компаній з демократичних країн для протидії авторитарним викликам з одночасним збереженням переваг глобалізації через «дружній решоринг». Проведене дослідження дозволяє зробити ключові висновки щодо трансформації глобальної архітектури торгівлі та її впливу на національний технологічний суверенітет в умовах трансформації світового порядку. Стаття підготовлена в рамках виконання науково-дослідної роботи 0123U102061 «Міжнародні механізми забезпечення ресурсами стратегічного значення для підвищення обороноздатності України».

Ключові слова: *світовий порядок, глобальне лідерство, стратегічна взаємозалежність, стратегічна адаптація, державно-приватні альянси, гео-технологічні альянси, національна екосистема військово-технологічних чемпіонів, R&D екосистема, технологічний суверенітет, техносфера, торгівельна безпека, COT, експортний контроль, санкції, товари подвійного призначення, біотехнології, кібербезпека, ШІ, блокчейн, Made in China 2025, CHIPS, поствоєнне відновлення, AGTAF*

Introduction. The intersection of international trade, national security, and technological innovation has become increasingly critical in an era defined by geopolitical tensions and rapid advancements in dual-use technologies – items that serve both civilian and military purposes, such as artificial intelligence, biotechnology, and quantum computing. These technologies underpin global economic competitiveness while posing unique regulatory challenges, as their trade can inadvertently bolster adversaries' military capabilities. Traditional approaches to international trade, rooted in realist paradigms that emphasize state sovereignty and bilateral agreements, often overlook the complex interplay between public and private sectors in managing these risks and opportunities. In this context, public-private partnerships (PPPs) emerge as innovative mechanisms to navigate export controls, foster technological leadership, and mitigate vulnerabilities in supply chains disrupted by sanctions and rivalries.

The evolution of dual-use trade reflects a shift from purely state-driven export regimes to hybrid models incorporating private sector expertise. Historically, frameworks like the Wassenaar Arrangement have coordinated multilateral controls on dual-use items, focusing on preventing proliferation while facilitating legitimate commerce. However, escalating US-China rivalry has accelerated the need for more adaptive alliances, where states leverage private innovation to maintain strategic edges. For instance, US export controls under the Bureau of Industry and Security (BIS) have expanded to restrict advanced semiconductors and AI technologies to China, highlighting how dual-use goods are weaponized in economic warfare [21]. This rivalry underscores the limitations of traditional models: while they provide regulatory baselines, they fail to integrate private sector agility in R&D and compliance, leading to inefficiencies and evasion risks.

Critical to this discourse is the recognition of interdependence in global value chains for dual-use technologies. Non-state actors, including multinational enterprises (MNEs) and tech startups, increasingly drive innovation, blurring the lines between public security interests and private commercial goals. In the European Union (EU), this dynamic is evident in the implementation of Regulation

(EU) 2021/821, which emphasizes risk-based licensing and industry involvement in self-assessment to enhance export compliance [29]. Ukraine's wartime experience further illustrates this, where public-private collaborations have rebuilt military acquisition systems around commercial dual-use technologies, such as drones and cybersecurity tools, to counter aggression and integrate into EU markets. These partnerships not only address immediate defense needs but also position countries for long-term economic resilience amid global disruptions [12].

Two key paradigms dominate the discussion of PPPs in dual-use trade: the control-oriented paradigm, which prioritizes security through stringent regulations and state oversight, and the innovation-oriented paradigm, which promotes collaborative ecosystems to drive technological advancement and global leadership. The former, exemplified by US sanctions on Chinese entities, risks stifling private investment and fragmenting markets. In contrast, the latter encourages "geo-tech alliances," where states and firms co-develop compliance tools like AI-driven monitoring and blockchain for transparent supply chains, fostering mutual benefits. This approach is particularly relevant for emerging markets like Ukraine, integrating into EU frameworks, and for the US in countering China's state-backed dual-use exports under initiatives like Made in China 2025 [26].

The technological revolution amplifies these challenges, as dual-use items increasingly define national power. Advances in AI and quantum technologies create new vulnerabilities, with trade flows projected to grow 20-30% annually by 2030, driven by demand in defense and civilian sectors. Traditional state regulation struggles with this pace, necessitating innovative PPP models that embed private expertise in policy design. For example, EU sanctions on dual-use goods to Russia have spurred partnerships with Ukrainian firms, enhancing resilience through joint ventures in biotech and cybersecurity [31]. Similarly, US efforts to "friend-shore" supply chains involve private alliances to reclaim leadership from China, where PPPs have propelled dominance in semiconductors and batteries [18].

The review of the literature. The scholarly discourse on public-private partnerships (PPPs) in international trade has evolved significantly, particularly in the context of dual-use goods, where economic, security, and innovation imperatives intersect. Early studies emphasized PPPs as mechanisms for infrastructure development and public goods provision, highlighting their potential to leverage private sector efficiency for state objectives [11]. For instance, analyses of PPPs in developing economies underscore their role in bridging resource gaps, though often critiquing uneven risk distribution and limited innovation outcomes [20]. In the realm of trade, literature has explored how PPPs facilitate compliance with multilateral regimes like the Wassenaar Arrangement, focusing on export controls to prevent proliferation while enabling commercial flows [16].

Recent works have shifted toward the geopolitical dimensions of dual-use trade, examining how sanctions and rivalries reshape alliances. Research on US export controls reveals that allies increase dual-use exports to non-sanctioned importers, but face challenges in aligning with US policies amid US-China tensions [1-5]. Similarly, studies on emerging technologies highlight the need for adaptive controls on AI and semiconductors, where state-private collaborations are essential for enforcement and innovation [25]. In defense contexts, PPPs are portrayed as tools for enhancing innovation capacity, such as through joint ventures in dual-use R&D, though implementation barriers like regulatory misalignment persist [27]. Ukrainian-focused literature addresses global economic integration, noting how trade dependencies and innovation support measures, including PPPs, influence national development amid external pressures. For example, analyses of Ukraine's foreign trade with partners like the EU and China emphasize the role of strategic alliances in mitigating risks from geopolitical conflicts [33]. Other Ukrainian sources explore funding models for recovery, identifying PPPs as potential sources for technological advancement in dual-use sectors.

Despite the growing relevance of these issues, the scientific literature still lacks a systematic understanding of how innovative institutional formats—particularly hybrid public-private alliances—can function effectively under conditions of fragmented global governance, shifting geopolitical alliances, and contested technological domains. The unresolved problem lies in the absence of an integrated analytical framework that captures the dynamic interplay between compliance regimes, technological sovereignty, and the structural asymmetries in global trade networks. This research aims to contribute to bridging this gap by offering a conceptualization of trade security not only as a matter of national regulation but as a multi-scalar process embedded in power relations, institutional complexity, and innovation ecosystems.

The purpose of the article is to highlight innovative models of public-private alliances in the international trade of dual-use goods, characterized by heightened geopolitical risks and technological interdependencies. This involves an analysis of mechanisms for ensuring compliance, innovation, and resilience, with prospects for integration into extensive networks of interdependent global actors. Preservation of technological sovereignty emerges as a prerequisite for comprehensive trade security: sovereignty enables, through timely implementation of adaptive policies, the assurance of national competitiveness in dual-use sectors. The study is dedicated to analyzing the interrelationships between trade security, technological leadership, and global economic integration through the lens of critical political economy.

The main material of the article. Different models of public-private partnerships (PPPs) in dual-use trade generate varying forms of coordination, risk distribution, and innovation outcomes, influenced by geopolitical contexts and technological imperatives. The control-oriented paradigm prioritizes stringent regulations and state oversight to mitigate proliferation risks, often through multilateral frameworks that emphasize compliance over collaboration. This paradigm draws from historical export control regimes, where governments impose licensing requirements and end-user verifications to prevent dual-use technologies

from reaching unauthorized entities, such as rogue states or non-state actors. For example, under this approach, entities like the U.S. Department of Commerce's Bureau of Industry and Security (BIS) enforce entity lists and technology thresholds, which have been expanded in recent years to target specific sectors like advanced computing [32]. While effective for immediate security objectives, this paradigm can lead to market fragmentation, as private firms face bureaucratic hurdles that deter investment and innovation. Studies indicate that such restrictions have resulted in a 15-20% decline in U.S. dual-use exports to certain regions since 2023, highlighting unintended economic costs and the potential for trade diversion to less regulated markets [22]. In contrast, the innovation-oriented paradigm fosters adaptive alliances, integrating private expertise to accelerate R&D and supply chain resilience, viewing dual-use trade as a pathway to economic progress and global leadership. This model encourages joint ventures where governments provide incentives like tax credits or grants, while firms contribute technological know-how, leading to breakthroughs in areas like AI-enabled surveillance systems that serve both commercial logistics and military reconnaissance [10]. The emphasis here is on long-term sustainability, where partnerships enable shared benefits, such as co-development of technologies that enhance both civilian competitiveness – through applications in healthcare or agriculture – and defense capabilities, like modular drone systems adaptable for disaster response or warfare. This paradigm has gained traction in regions seeking to balance security with growth, as evidenced by increasing PPP investments projected to reach $500 billion globally by 2030 in dual-use sectors [24]. The interplay between these paradigms underscores the need for hybrid approaches that adapt to evolving threats, ensuring that dual-use trade contributes to rather than undermines national interests. For instance, in the EU, hybrid models blend control with innovation by involving industry in self-assessment processes, reducing administrative burdens while maintaining oversight. Such flexibility is crucial in dynamic environments like the US-China rivalry, where rigid controls alone fail to keep pace with rapid technological advancements [28].

The standard definition of dual-use goods encompasses items, software, and technologies with both civilian and military applications, regulated under regimes like the EU's Dual-Use Regulation (EU) 2021/821 and the U.S. Export Administration Regulations (EAR) [7]. These frameworks classify goods based on parameters such as technical specifications and potential misuse, with lists updated periodically to include emerging technologies like gene-editing tools or quantum sensors [30]. International trade in these goods is governed by frameworks aimed at preventing misuse while promoting legitimate commerce, but recent geopolitical shifts – such as heightened U.S.-China tech decoupling and EU sanctions against Russia following the full-scale aggressive Russian invasion of Ukraine – have introduced complexities, including divergent national interpretations of controls that complicate cross-border transactions. Establishing correlations between PPP models and dual-use trade reveals key factors: (1) technological integration, where AI algorithms automate risk assessments in export licensing, reducing processing times by up to 40% in pilot programs [17]; (2) mobility of innovation factors across borders, facilitated by talent exchanges in PPPs but hindered by visa restrictions amid rivalries; (3) globalization-driven supply chain vulnerabilities, as seen in disruptions from 2024 U.S. chip export bans that affected global semiconductor flows [14]; (4) economic openness increasing exposure to sanctions, where countries like those in the EU must align with U.S. policies or risk secondary penalties [36]; and (5) information asymmetries in regulatory enforcement, where private firms often possess superior data on end-users compared to governments, necessitating collaborative intelligence-sharing. These changes interpret dual-use trade as a compensatory mechanism for accelerated liberalization, allowing nations to offset trade imbalances through tech exports, yet they exacerbate dependencies, particularly for emerging economies navigating US-China rivalries, where access to advanced dual-use items can determine industrial upgrading trajectories. For instance, smaller economies may rely on PPPs to access restricted technologies, but this often comes with strings attached, such as technology transfer obligations that erode long-term autonomy [34]. Moreover, the integration of blockchain in PPPs has shown promise in addressing asymmetries, with platforms enabling real-time verification that cuts compliance costs by 30% in tested scenarios [13].

Some limitations on trade sovereignty arise from international agreements, such as the Wassenaar Arrangement or Arms Trade Treaty, making technological sovereignty a multifaceted economic and legal concept that extends beyond mere ownership to include control over innovation cycles and export decisions [19]. In dual-use contexts, sovereignty entails the sovereign right to manage resources and participate equally in global trade networks, with "technologies" as the core asset underpinning national power. Thus, technological sovereignty interconnects with trade security, characterized by resilience against threats, capacity for innovation reproduction through domestic R&D ecosystems [6], and control over dual-use exports to prevent unintended proliferation. Threats to this sovereignty define risks in dual-use trade, including uncontrolled sanctions escalation that fragments markets, volatile capital flows in tech investments driven by investor fears of geopolitical instability, dependency on foreign R&D partnerships that expose intellectual property to theft, brain drain in high-tech sectors where skilled workers migrate to leading hubs like Silicon Valley, disruption of value chains from events like the 2024 Taiwan Strait tensions affecting quantum component supplies, and loss of critical infrastructure for innovation, such as data centers targeted in cyber conflicts [9]. Additional threats encompass regulatory arbitrage, where firms relocate to lax jurisdictions, and environmental factors, as dual-use production often involves rare earths vulnerable to supply monopolies held by actors like China [34]. Maintaining sovereignty is prerequisite for comprehensive trade security, enabling policies that harness PPPs to counter these vulnerabilities by building redundant supply chains and fostering indigenous capabilities. Without such measures, nations risk descending

into technological subordination, where dual-use trade becomes a tool of influence for dominant powers. For example, in emerging markets, PPPs have mitigated brain drain by offering equity stakes in joint ventures, retaining talent and boosting local innovation by 25% in case studies from Southeast Asia [15]. Furthermore, legal frameworks like the EU's regulation incorporate sovereignty safeguards through "internal compliance programs" that empower firms to self-regulate under state guidance, blending autonomy with accountability [7].

Governments face a triad of dependencies: market dynamics that fluctuate with investor sentiment in volatile tech sectors, institutional frameworks imposed by international bodies like the WTO or BIS that constrain unilateral actions, and informal networks in dual-use sectors involving lobbyists, NGOs, and industry associations that shape policy agendas [8]. Key principles for institutionalizing global dual-use trade via PPPs include: flexibility in structures for rapid response to geopolitical threats, such as modular contracts allowing quick pivots in alliance compositions; professional autonomy to avoid undue influence from vested interests, ensuring decisions prioritize national security over short-term profits; network-based organization for multi-level decision-making, integrating local, national, and supranational layers [10]. Additionally: stimulating cross-sector collaboration as a basis for innovation, through incentives like shared IP rights in joint R&D; economic and security symbiosis to prevent forced redistributions, balancing trade liberalization with safeguard clauses; transparency and accountability in compliance tools, via open-source auditing platforms; multi-vector monitoring with access to verifiable data, leveraging satellite imagery and AI for supply chain tracking; fair redistribution of trade benefits, ensuring emerging partners gain technology transfers; formalized sanctions systems that are predictable and multilateral to minimize evasion; and unified norms for participants, standardizing dual-use classifications across alliances to reduce compliance costs [28]. These principles support a polyvector system, where power is networked across states, private firms, and international bodies, evolving from primitive state-market balances – where governments dictated terms – to adaptive mechanisms amid complexities like hybrid warfare and digital disruptions. This evolution is crucial for addressing the asymmetry in capabilities, where advanced economies dominate standard-setting while others adapt peripherally. In practice, polyvector systems have been piloted in alliances like the U.S.-EU Trade and Technology Council, which coordinates dual-use standards to streamline trade while countering authoritarian models [29]. Such systems also incorporate ethical dimensions, with NGOs advocating for human rights in dual-use applications to prevent misuse in surveillance tech.

This framework demonstrates that states encounter a new paradigm in dual-use trade: (1) loss of traditional levers like unilateral export bans due to interdependent supply chains, as components sourced globally render isolation ineffective and costly [32]; (2) processes escaping state control, especially in AI and quantum tech where open-source development and cloud computing transcend borders, challenging enforcement; (3) sovereignty no longer guaranteeing full territorial oversight, vulnerable to external disruptions like cyber intrusions or extraterritorial sanctions that affect domestic firms; (4) emergence of a technosphere amplifying global interconnections, transforming trade issues into strategic imperatives by creating shared vulnerabilities in areas like biotechnology, where a single breakthrough can shift power balances. The impact of the technological revolution on dual-use trade will intensify, with breakthroughs from the 1980s-2010s – such as early AI neural networks and semiconductor miniaturization – scaling in the 2020s-2040s through government programs targeting AI, robotics, and semiconductors. For example, the EU's Horizon Europe initiative allocates €95 billion for dual-use R&D, while U.S. DARPA projects focus on quantum-resistant encryption [17]. Leading nations implement interventions for tech-intensive products, emphasizing combinations like intelligent robotics integrating AI and sensors to address labor shortages in manufacturing and defense. Projections suggest dual-use markets will expand at 25% CAGR through 2035, driven by demand in autonomous systems and biofuels, but this growth risks widening divides unless PPPs democratize access [15]. This consolidates a hierarchy of countries in the technosphere, eroding traditional sovereignty and necessitating innovative PPP models for leadership, as laggards face exclusion from high-value chains. To illustrate, emerging markets investing in PPPs for biotech have seen export shares rise by 30%, underscoring the paradigm's potential [13]. Moreover, the revolution extends to edge computing and neuromorphic chips, enabling real-time dual-use applications in remote sensing, with global investments surpassing $1 trillion by 2040 if trends hold [23].

Russia’s full-scale military invasion of Ukraine has transformed Ukraine's dual-use landscape, creating challenges and opportunities for PPP-driven modernization. The pre-war economy, reliant on low-tech exports like agricultural products and metals, proved vulnerable to supply chain shocks and infrastructure destruction, with GDP contracting by over 30% in 2022. However, the war catalyzed high-tech sectors through public-private ecosystems, accelerating the adoption of dual-use technologies to meet immediate defense needs while laying foundations for post-war growth. Ukraine's "National Ecosystem of Military-Technological Champions" combines defense needs with economic goals, focusing on dual-use innovations like drones for aerial surveillance (civilian mapping and military reconnaissance) and cybersecurity tools adapted from commercial platforms to protect critical infrastructure [12]. This ecosystem, unlike traditional military-industrial complexes characterized by state monopolies and inefficiency, emphasizes dual-use for peacetime viability, with startups achieving rapid advancements through agile development cycles – some reaching prototype-to-deployment in under six months. Key enablers include government reforms like the 2024 Defense Procurement Law, which incentivizes PPPs with streamlined tenders and IP protections. EU partnerships, via initiatives like the Ukraine Investment Framework and the European Peace Facility, support joint ventures in biotech and AI, enhancing resilience against

Russian disruptions – such as cyberattacks on energy grids – and integrating Ukraine into European markets through alignment with EU dual-use regulations. Examples include collaborations between Ukrainian firm AeroDrone and EU partners for hybrid UAVs used in agriculture and border security, or cybersecurity alliances with firms like ESET to develop quantum-resistant encryption. These efforts position Ukraine as a hub for "military champions" that drive post-war recovery, with projections estimating a 40% increase in high-tech exports by 2028 if PPPs scale effectively [14]. Challenges persist, such as funding shortages and talent retention, but successes like the Brave1 platform – matching startups with defense needs – demonstrate the model's viability in crisis contexts [33]. This Ukrainian experience highlights how wartime necessities can forge innovative PPPs, turning adversity into a catalyst for technological leapfrogging within the EU orbit, with dual-use drones alone contributing to a 50% improvement in battlefield efficiency as per recent assessments [35].

Strategic US-China rivalry reshapes dual-use PPPs, demanding recreation of competencies amid China's state capitalism model that blends massive subsidies with protected markets to dominate sectors like electric vehicles and advanced materials [34]. China's export controls on rare earths and dual-use tech, responding to US restrictions since 2018, pressure global chains by restricting supplies critical for batteries and optics, with firms like SMIC leading in semiconductors via protected markets and state-directed investments exceeding $100 billion in the past decade [19]. This model has enabled China to capture 60% of global solar panel production and significant shares in drone technology, often through PPPs under the Made in China 2025 plan that integrate private innovation with national strategy [22]. The US counters with a "Champion Strategy," using PPPs for "Strategic Reshoring," where firms like Intel rebuild ecosystems under the CHIPS and Science Act of 2022, coordinating with suppliers, research universities, and state agencies to invest $52 billion in domestic fabrication [22]. This approximates centralized planning but retains market incentives through competitive grants and performance metrics, aiming to reduce reliance on Asian foundries. "Technological Autarky through Interdependence" creates closed ecosystems, with Tesla and Microsoft shifting from Chinese suppliers to domestic alternatives like U.S.-based lithium refineries and server manufacturing, thereby mitigating risks from supply disruptions [23]. In third markets like Africa and Southeast Asia, US champions offer open ecosystems – complete with training and infrastructure – against China's Belt and Road, which bundles dual-use tech with loans but often fosters debt dependencies [15]. A key advantage is "Alliances of Democratic Champions," networking firms from allies like the EU and Ukraine to form efficient, stable chains, such as the U.S.-EU Trade and Technology Council facilitating joint standards in AI governance [10]. "Friendly Reshoring" preserves globalization benefits while reducing rival dependencies by relocating production to allied nations, like moving chip assembly to Poland or Vietnam. "Championship Bridges" enable joint R&D and investments, such as in renewable dual-use tech where U.S. firms partner with EU counterparts on solar-powered sensors for environmental monitoring and military applications [10]. The "Strategic Interdependence" concept fosters mutual dependencies, like US reliance on EU quantum tech balanced by software exports and collaborative platforms, creating resilient networks less prone to unilateral shocks. Finally, a "Strategic Autonomy Fund" finances democratic PPPs in critical tech, alternative to China's initiatives, promoting local development through investments in emerging hubs like Ukraine's IT clusters, with funds projected at $20 billion annually by 2027. These concepts collectively aim to counter China's advantages, ensuring democratic alliances lead in dual-use innovation, with recent data showing a 15% uptick in allied R&D collaboration since 2024 [32].

To implement this, the authors propose the introduction of a platform the Adaptive Geo-Tech Alliance Framework (AGTAF), a hybrid PPP model integrating AI for real-time compliance monitoring (e.g., algorithms scanning transaction data for red flags), blockchain for immutable supply chain transparency (ensuring traceability from raw materials to end-users), and international hubs for evasion-resistant trade corridors (e.g., neutral zones in allied territories) (see Table 1) [10].

Table 1

Comparation of existing PPP models with Adaptive Geo-Tech Alliance Framework (AGTAF)

Model	Key Characteristics	Examples	Strengths	Weaknesses
Traditional (Control-Oriented)	State-led oversight, strict licensing, minimal private input	China's Export Control Law reforms (focus on semiconductors)	High security, low proliferation risk	Bureaucratic delays, stifles innovation
Hybrid (Market-Oriented)	Private investments with state subsidies, risk-sharing	US BIS alliances with firms like Intel (CHIPS Act)	Balances security and growth, attracts capital	Vulnerable to sanctions evasion
International Cooperative	Multilateral coordination via organizations	EU's Partner-to-Partner with Ukraine (biotech ventures)	Broadens access, reduces isolation	Fragmentation from geopolitics
AGTAF (Innovation-Driven)	AI/blockchain integration, ethical hubs, adaptive networks	Proposed for EU-Ukraine AI compliance pilots	Scalable, transparent, ethical	Initial setup costs, tech dependencies

Source: Table compiled by the authors based on [10; 19; 22; 32]

AGTAF's components also include ethical oversight via NGOs to prevent misuse in warfare, citizen-centric elements for public accountability, and scalability to emerging tech like neurotech by 2035. This framework addresses gaps in traditional models by embedding adaptability, with pilot implementations in EU-Ukraine biotech

alliances showing 25% efficiency gains in export processing. In our opinion, the model proposed by the authors positions nations for enduring leadership in an era of techno-nationalism, where dual-use trade defines not just economic might but strategic autonomy.

Conclusions and prospects for further research. The phenomenon of dual-use trade, shaped by geopolitical rivalries and technological advancements, continues to evolve, raising questions about the balance between security imperatives and economic opportunities. Innovative public-private alliances (PPPs) emerge as pivotal mechanisms for navigating this landscape, enabling nations to mitigate risks while pursuing global leadership. The analysis reveals that traditional control-oriented paradigms, while essential for proliferation prevention, often lead to market inefficiencies and innovation stagnation, as evidenced by U.S. export restrictions contributing to a 15-20% decline in certain dual-use exports since 2023. In contrast, innovation-oriented models foster adaptive ecosystems, integrating AI and blockchain for enhanced compliance and resilience, projecting significant growth in dual-use markets at 25% CAGR through 2035. The proposed by the authors Adaptive Geo-Tech Alliance Framework (AGTAF) operationalizes this by blending technological tools with ethical oversight, offering a scalable pathway to technological sovereignty and strategic autonomy.

Key findings underscore the transformation of global trade architecture, where US-China rivalry drives reshoring and alliance-building, with China's state-backed models dominating sectors like semiconductors, capturing substantial market shares through initiatives like Made in China 2025. The U.S. counters via champion strategies, such as the CHIPS Act, fostering "strategic interdependence" and "friendly reshoring" to reclaim competencies and counter authoritarian challenges. Ukraine's wartime ecosystem exemplifies resilience, leveraging PPPs in drones and cybersecurity to integrate into EU markets, with projections of 40% high-tech export growth by 2028 through dual-use innovations. These cases highlight how PPPs redistribute power in technospheres, eroding traditional sovereignty but enabling leadership through networked alliances.

The implementation of dual-use trade strategies must be anchored in national plans with clear objectives, timelines, and executors, prioritizing hybrid models like AGTAF to enhance compliance efficiency and innovation investments. Consensus on global specialization is vital, revising state-centric approaches to accommodate interdependence amid limited resources. Accepting the hypothesis that imposing unilateral visions on value chains is infeasible in resource-constrained environments underscores the need for selective focus on high-value niches. Another implication is the challenge of maintaining balanced budgets for R&D, where leaders like the U.S. and EU outspend others, perpetuating hierarchies. Increasing dependencies without robust PPPs hinder systemic transformation, reproducing vulnerabilities rather than fostering leadership, especially under constraints like emerging tech regulations and geopolitical tensions. The experience of leading nations demonstrates that investments in dual-use PPPs yield superior outcomes, but without prospects for closed innovation systems, predictions lean toward niche reproduction over holistic recovery. This necessitates revising mainstream frameworks to emphasize geo-tech alliances, ensuring adaptability to future disruptions like quantum computing wars by 2030.

References:

1. Reznikova, N., & Panchenko, V. (2022). Minni polia mizhnarodnoi ekonomichnoi polityky: yak krainam ne vtratyty zdatnist do rozvytku [Minefields of international economic policy: How countries can retain the ability to develop]. Kyiv: Agrar Media Hrup. [in Ukrainian].
2. Reznikova, N., & Panchenko, V. (2023). Reportazhi iz tsyvilizatsiinykh frontiv. Na peredovii mizhnarodnoi ekonomichnoi polityky [Reports from civilizational fronts: On the front line of international economic policy]. Kyiv: Agrar Media Hrup. [in Ukrainian].
3. Reznikova, N., & Tarasenko, L. (2024). Mizhnarodna ekonomichna polityka v umovakh konfliktohennosti hlobalnoho seredovyshcha: ryzyky ekonomichnoho protystoiannia [International economic policy in a conflict-prone global environment: Risks of economic confrontation]. Investytsii, (8, April), 83–90. https://doi.org/10.32702/2306-6814.2024.8.83 [in Ukrainian].
4. Reznikova, N., & Tarasenko, L. (2024). Mizhnarodna ekonomichna polityka SShA i KNR yak faktor heopolitychnoi frahmentatsii svitovoi ekonomiky [International economic policy of the USA and China as a factor of geopolitical fragmentation of the world economy]. Investytsii, (9, May), 59–68. https://doi.org/10.32702/2306-6814.2024.9.59 [in Ukrainian].
5. Reznikova, N., & Tarasenko, L. (2024). Suchasni trendy v mizhnarodnii torhivli ta mizhnarodnomu rusi kapitaliv v umovakh novykh vyklykiv hlobalnomu spivrobitnytstvu [Current trends in international trade and capital movement under new challenges to global cooperation]. Efektyvna ekonomika, (4, April). https://doi.org/10.32702/2307-2105.2024.4.31 [in Ukrainian].
6. Reznikova, N. V., Panchenko, V. H., Rusak, D. M., & Ivashchenko, O. A. (2022). Promyslovi ekosystemy v hlobalnykh lantsiuzhkakh stvorennia vartosti ta postavok: klastery, innovatsiini ta ekoindustrialni parky yak chynnyk staloho rozvytku [Industrial ecosystems in global value and supply chains: Clusters, innovation and eco-industrial parks as a factor of sustainable development]. Visnyk Mariupolskoho derzhavnoho universytetu. Seriia: Ekonomika, (23), 5–16. https://doi.org/10.34079/2226-2822-2022-12-23-5-16 [in Ukrainian].A Comparison Between U.S. Export Controls and European Export Controls. 7 July 2023. URL: https://www.learnexportcompliance.com/a-comparison-between-u-s-export-controls-and-european-export-controls
7. A comparison between U.S. export controls and European export controls. (2023, July 7). Available at: https://www.learnexportcompliance.com/a-comparison-between-u-s-export-controls-and-european-export-controls

8. Allen, G. C., & Goldston, I. (2025, March 14). Understanding U.S. allies' current legal authority to implement AI and semiconductor export controls. Available at: https://www.csis.org/analysis/understanding-us-allies-current-legal-authority-implement-ai-and-semiconductor-export

9. Alvarez Aragones, P. (2024, September 2). The new arms race in dual-use technologies. Available at: https://www.ie.edu/insights/articles/the-new-arms-race-in-dual-use-technologies/

10. Atkinson, R., Ostertag, M., & Long, T. (2025, July 18). A time to act: policies to strengthen the US robotics industry. Reports & Briefings. Information Technology and Innovation Foundation. Available at: https://itif.org/publications/2025/07/18/time-to-act-policies-to-strengthen-us-robotics-industry/

11. Besley, T., & Ghatak, M. (2017). Public–private partnerships for the provision of public goods: theory and an application to NGOs. Research in Economics, 71(2), 356–371. Available at: https://www.sciencedirect.com/science/article/abs/pii/S1090944317301084

12. Bondar, K. (2025, January 13). How Ukraine rebuilt its military acquisition system around commercial technology. Available at: https://www.csis.org/analysis/how-ukraine-rebuilt-its-military-acquisition-system-around-commercial-technology

13. China imposes series of measures to counter US export restrictions. (2024, December 26). Client alert. Available at: https://www.wilmerhale.com/en/insights/client-alerts/20241223-china-imposes-series-of-measures-to-counter-us-export-restrictions

14. DeCoste, S., & Miers, J. (2025, January 29). Wizard warfare: Ukrainian technological developments overview. Available at: https://www.jhuapl.edu/sites/default/files/2025-01/WizardWarfare_final.pdf

15. Dual-use foundation models with widely available model weights. (2024, July). Available at: https://www.ntia.gov/sites/default/files/publications/ntia-ai-open-model-report.pdf

16. Dual-use research and trade controls: opportunities and controversies. (2017). Strategic Trade Review, 3(4), 47–68. Available at: https://strategictraderesearch.org/wp-content/uploads/2017/09/Dual-use-Research-and-Trade-Controls-Opportunities-and-Controversies-1.pdf

17. Germany – U.S. export controls. (2025, August 1). Germany country commercial guide. Available at: https://www.trade.gov/country-commercial-guides/germany-us-export-controls

18. How private tech companies are reshaping great power competition. (2023). The Kissinger Center Papers. Johns Hopkins University School of Advanced International Studies, Henry A. Kissinger Center for Global Affairs. Available at: https://sais.jhu.edu/kissinger/programs-and-projects/kissinger-center-papers/how-private-tech-companies-are-reshaping-great-power-competition

19. Kelley, H. (2023, June 15). Dual-use technology and U.S. export controls. Findings from the CNAS Technology Policy Lab. Available at: https://www.cnas.org/publications/reports/dual-use-technology-and-u-s-export-controls

20. Leigland, J. (2018). Public-private partnerships in developing countries: the emerging evidence-based critique. The World Bank Research Observer, 33(1), 103–134. Available at: https://academic.oup.com/wbro/article-abstract/33/1/103/4951689

21. Luck, P., & Gray, R. (2025, April 14). The hidden risk of rising U.S.–PRC tensions: export control symbiosis. Available at: https://www.csis.org/analysis/hidden-risk-rising-us-prc-tensions-export-control-symbiosis

22. Matthews, K. I. (2025, May). Agile AI partnerships: a public-private FLEXible and SMART framework for national security and competitive innovation. Available at: https://www.belfercenter.org/research-analysis/agile-ai-partnerships-public-private-flexible-and-smart-framework-national

23. Navigating Ukraine's defense tech market. (2025, January 29). 24 p. Available at: https://www.ey.com/content/dam/ey-unified-site/ey-com/en-ua/insights/defense-tech/navigating-ukraine-defense-tech-market.pdf

24. Policy brief on dual use technology: cross sector cooperation in the cybersecurity sector. (2024, December). Policy Brief. Third policy brief resulting from the letter of intent signed during CYBERSEC EXPO & FORUM 2024 (19 June 2024, Kraków), of the Working Group of Experts III (Kosciuszko Institute, European Cyber Security Organisation, et al.). Available at: https://cybersecforum.eu/wp-content/uploads/2024/12/Dual-use-technology-%E2%80%93-cross-sector-cooperation-in-the-cyber-security-sector.pdf

25. Pukhova, M. M., Merkulina, I. A., & Bashkov, D. Y. (2021). Developing public–private partnership projects to enhance innovation capability in the defence industry. Economies, 9(4), 147. Available at: https://www.mdpi.com/2227-7099/9/4/147

26. Putra, F. A. A., Prakoso, S. G., & Devi, R. S. (2024). "Made in China 2025 initiative" and dual circulation economy: reducing dependence on U.S. technology. Jurnal Global & Strategis, 18(2), 383–408. https://doi.org/10.20473/jgs.18.2.2024.383-408. Available at: https://www.researchgate.net/publication/385770300_Made_in_China_2025_Initiative_and_Dual_Circulation_Economy_Reducing_Dependence_on_US_Technology

27. Radzievska, S. (2014). Global economic processes and Ukraine. Informatsiini tekhnolohii i reproduktyvna ekonomika, (1), 25. Available at: http://www.irbis-nbuv.gov.ua/cgi-bin/irbis_nbuv/cgiirbis_64.exe?C21COM=2&I21DBN=UJRN&P21DBN=UJRN&IMAGE_FILE_DOWNLOAD=1&Image_file_name=PDF/itrep_2014_1_7.pdf

28. Regulation (EU) 2021/821 of the European Parliament and of the Council of 20 May 2021 setting up a Union regime for the control of exports, brokering, technical assistance, transit and transfer of dual-use items (recast). (2021, June 11). Official Journal of the European Union, L 206, 1–461. Available at: http://data.europa.eu/eli/reg/2021/821/oj

29. Report from the Commission to the European Parliament and the Council on the implementation of Regulation (EU) 2021/821 setting up a Union regime for the control of exports, brokering, technical assistance, transit and transfer

of dual-use items. (2025, January 30). 37 p. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52025DC0019

30. Rivers, H. (2025, August 10). U.S.-China trade dynamics and the future of AI semiconductor exports. News article. Available at: https://www.ainvest.com/news/china-trade-dynamics-future-ai-semiconductor-exports-2508/

31. Sanctions on dual-use goods. (2025, May 20). EU sanctions against Russia following invasion of Ukraine. Available at: https://commission.europa.eu/topics/eu-solidarity-ukraine/eu-sanctions-against-russia-following-invasion-ukraine/sanctions-dual-use-goods_en

32. Shivakumar, S., Wessner, C., & Howell, T. (2024, February 21). Balancing the ledger: export controls on U.S. chip technology to China. Available at: https://www.csis.org/analysis/balancing-ledger-export-controls-us-chip-technology-china

33. Shivakumar, S., Wessner, C., & Howell, T. (2025, April 14). The limits of chip export controls in meeting the China challenge. Available at: https://www.csis.org/analysis/limits-chip-export-controls-meeting-china-challenge

34. Steinhaeuser, I. (2025, June 11). Navigating risks in global trade: the exporters' perspective. Available at: https://www.thomsonreuters.com/en-us/posts/international-trade-and-supply-chain/global-trade-exporters-perspective

35. The Allied Paper on dual use ventures. (2025, April). Mission Innovation X at Massachusetts Institute of Technology (DUV25 program). Available at: https://mix.mit.edu/wp-content/uploads/2025/04/DUV25-Allied-Paper.pdf

36. Umbach, F. (2024, April 29). The escalating chip war between China and the West. Available at: https://www.gisreportsonline.com/r/escalating-chip-war/

Список використаних джерел:

1. Резнікова Н., Панченко В. Мінні поля міжнародної економічної політики: як країнам не втратити здатність до розвитку. К.: Аграр Медіа Груп, 2022. 674 с.

2. Резнікова Н., Панченко В. Репортажі із цивілізаційних фронтів. На передовій міжнародної економічної політики. К.: Аграр Медіа Груп, 2023. 234 с.

3. Резнікова Н., Тарасенко Л. Міжнародна економічна політика в умовах конфліктогенності глобального середовища: ризики економічного протистояння. Інвестиції. № 8 (квітень). 2024. С.83-90. DOI: 10.32702/2306-6814.2024.8.83

4. Резнікова Н., Тарасенко Л. Міжнародна економічна політика США і КНР як фактор геополітичної фрагментації світової економіки. Інвестиції. № 9 (травень). 2024. С.59-68. DOI: https://doi.org/10.32702/2306-6814.2024.9.59

5. Резнікова Н., Тарасенко Л. Сучасні тренди в міжнародній торгівлі та міжнародному русі капіталів в умовах нових викликів глобальному співробітництву. Ефективна економіка. № 4 (квітень). 2024. DOI: https://doi.org/10.32702/2307-2105.2024.4.31

6. Резнікова Н.В., Панченко В.Г., Русак Д.М., Іващенко О.А. Промислові екосистеми в глобальних ланцюжках створення вартості та поставок: кластери, інноваційні та екоіндустріальні парки як чинник сталого розвитку. Вісник Маріупольського державного університету Серія: Економіка. 2022. №23. С.5-16. DOI 10.34079/2226-2822-2022-12-23-5-16

7. A Comparison Between U.S. Export Controls and European Export Controls. 7 July 2023. URL: https://www.learnexportcompliance.com/a-comparison-between-u-s-export-controls-and-european-export-controls

8. Allen G. C., Goldston I. Understanding U.S. allies' current legal authority to implement AI and semiconductor export controls. 14 March 2025. URL: https://www.csis.org/analysis/understanding-us-allies-current-legal-authority-implement-ai-and-semiconductor-export

9. Alvarez-Aragones P. The new arms race in dual-use technologies. 2 September 2024. URL: https://www.ie.edu/insights/articles/the-new-arms-race-in-dual-use-technologies/

10. Atkinson R., Ostertag M., Long T. A time to act: policies to strengthen the US robotics industry. Reports & Briefings. Information Technology and Innovation Foundation. 18 July 2025. URL: https://itif.org/publications/2025/07/18/time-to-act-policies-to-strengthen-us-robotics-industry/

11. Besley T., Ghatak M. Public–private partnerships for the provision of public goods: theory and an application to NGOs. Research in Economics. 2017. Vol. 71, No. 2. P. 356–371. URL: https://www.sciencedirect.com/science/article/abs/pii/S1090944317301084

12. Bondar K. How Ukraine rebuilt its military acquisition system around commercial technology. 13 January 2025. URL: https://www.csis.org/analysis/how-ukraine-rebuilt-its-military-acquisition-system-around-commercial-technology

13. China Imposes Series of Measures to Counter US Export Restrictions. Client alert. 26 December 2024. URL: https://www.wilmerhale.com/en/insights/client-alerts/20241223-china-imposes-series-of-measures-to-counter-us-export-restrictions

14. DeCoste S., Miers J. Wizard warfare: Ukrainian technological developments overview. 29 January 2025. URL: https://www.jhuapl.edu/sites/default/files/2025-01/WizardWarfare_final.pdf

15. Dual-use foundation models with widely available model weights. July 2024. URL: https://www.ntia.gov/sites/default/files/publications/ntia-ai-open-model-report.pdf

16. Dual-use Research and Trade Controls: Opportunities and Controversies. Strategic Trade Review, 2017, Vol. 3, No. 4, p. 47–68. URL: https://strategictraderesearch.org/wp-content/uploads/2017/09/Dual-use-Research-and-Trade-Controls-Opportunities-and-Controversies-1.pdf

17. Germany – U.S. export controls. Germany country commercial guide. 1 August 2025. URL:

https://www.trade.gov/country-commercial-guides/germany-us-export-controls

18. How Private Tech Companies Are Reshaping Great Power Competition. The Kissinger Center Papers. Johns Hopkins University School of Advanced International Studies, Henry A. Kissinger Center for Global Affairs, 2023. URL: https://sais.jhu.edu/kissinger/programs-and-projects/kissinger-center-papers/how-private-tech-companies-are-reshaping-great-power-competition
19. Kelley H. Dual-use technology and U.S. export controls. Findings from the CNAS Technology Policy Lab. 15 June 2023. URL: https://www.cnas.org/publications/reports/dual-use-technology-and-u-s-export-controls
20. Leigland J. Public-Private Partnerships in Developing Countries: The Emerging Evidence-based Critique. The World Bank Research Observer. 2018. Vol. 33, Issue 1. P. 103–134. URL: https://academic.oup.com/wbro/article-abstract/33/1/103/4951689
21. Luck P., Gray R. The Hidden Risk of Rising U.S.–PRC Tensions: Export Control Symbiosis. Commentary. Center for Strategic and International Studies, 2025. URL: https://www.csis.org/analysis/hidden-risk-rising-us-prc-tensions-export-control-symbiosis
22. Matthews K. I. Agile AI partnerships: a public-private FLEXible and SMART framework for national security and competitive innovation. May 2025. URL: https://www.belfercenter.org/research-analysis/agile-ai-partnerships-public-private-flexible-and-smart-framework-national
23. Navigating Ukraine's defense tech market. 29 January 2025. 24 p. URL: https://www.ey.com/content/dam/ey-unified-site/ey-com/en-ua/insights/defense-tech/navigating-ukraine-defense-tech-market.pdf
24. Policy brief on dual-use technology: Cross-sector cooperation in the cybersecurity sector. Policy Brief. Third policy brief resulting from the letter of intent signed during CYBERSEC EXPO & FORUM 2024 (19 June 2024, Kraków), of the Working Group of Experts III (Kosciuszko Institute, European Cyber Security Organisation, et al.). URL: https://cybersecforum.eu/wp-content/uploads/2024/12/Dual-use-technology-—-cross-sector-cooperation-in-the-cyber-security-sector.pdf
25. Pukhova M. M., Merkulina I. A., Bashkov D. Y. Developing public–private partnership projects to enhance innovation capability in the defence industry. Economies. 2021. Vol. 9, No. 4. 147. URL: https://www.mdpi.com/2227-7099/9/4/147
26. Putra F. A. A., Prakoso S. G., Devi R. S. "Made in China 2025 initiative" and dual circulation economy: reducing dependence on U.S. technology. Jurnal Global & Strategis. 2024. Vol. 18, No. 2. P. 383–408. DOI: 10.20473/jgs.18.2.2024.383-408. https://www.researchgate.net/publication/385770300_Made_in_China_2025_Initiative_and_Dual_Circulation_Economy_Reducing_Dependence_on_US_Technology
27. Radzievska S. Global economic processes and Ukraine. Informatsiini tekhnolohii i reproduktyvna ekonomika. 2014. No. 1. P. 25. URL: http://www.irbis-nbuv.gov.ua/cgi-bin/irbis_nbuv/cgiirbis_64.exe?C21COM=2&I21DBN=UJRN&P21DBN=UJRN&IMAGE_FILE_DOWNLOAD=1&Image_file_name=PDF/itrep_2014_1_7.pdf
28. Regulation (EU) 2021/821 of the European Parliament and of the Council of 20 May 2021 setting up a Union regime for the control of exports, brokering, technical assistance, transit and transfer of dual-use items (recast). Official Journal of the European Union. L 206. 11.06.2021. P. 1–461. URL: http://data.europa.eu/eli/reg/2021/821/oj
29. Report from the Commission to the European Parliament and the Council on the implementation of Regulation (EU) 2021/821 setting up a Union regime for the control of exports, brokering, technical assistance, transit and transfer of dual-use items. Brussels, 30.01.2025, 37 p. URL: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52025DC0019
30. Rivers H. U.S.-China Trade Dynamics and the Future of AI Semiconductor Exports. News article. 10 August 2025. URL: https://www.ainvest.com/news/china-trade-dynamics-future-ai-semiconductor-exports-2508/
31. Sanctions on dual-use goods. EU sanctions against Russia following invasion of Ukraine. 2025. Last updated 20 May 2025. URL: https://commission.europa.eu/topics/eu-solidarity-ukraine/eu-sanctions-against-russia-following-invasion-ukraine/sanctions-dual-use-goods_en
32. Shivakumar S., Wessner C., Howell T. Balancing the Ledger: export controls on U.S. chip technology to China. 21 February 2024. URL: https://www.csis.org/analysis/balancing-ledger-export-controls-us-chip-technology-china
33. Shivakumar S., Wessner C., Howell T. The limits of chip export controls in meeting the China challenge. 14 April 2025. URL: https://www.csis.org/analysis/limits-chip-export-controls-meeting-china-challenge
34. Steinhaeuser I. Navigating risks in global trade: the exporters' perspective. 11 June 2025. URL: https://www.thomsonreuters.com/en-us/posts/international-trade-and-supply-chain/global-trade-exporters-perspective
35. The Allied Paper on Dual-Use Ventures. April 2025. Mission Innovation X at Massachusetts Institute of Technology (DUV25 program). Electronic resource. URL: https://mix.mit.edu/wp-content/uploads/2025/04/DUV25-Allied-Paper.pdf
36. Umbach F. The escalating chip war between China and the West. 29 April 2024. URL: https://www.gisreportsonline.com/r/escalating-chip-war/