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GREENING OF VALUE CHAINS AND CLIMATE-TECHNOLOGICAL DECOUPLING: THE ARCHITECTURE OF A NEW INTERNATIONAL DIVISION OF LABOUR THROUGH GREEN ARTIFICIAL COMPETITIVE ADVANTAGES

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ОЗЕЛЕНЕННЯ ЛАНЦЮГІВ ВАРТОСТІ І КЛІМАТИЧНО-ТЕХНОЛОГІЧНИЙ ДЕКАПЛІНГ: ЗЕЛЕНІ ШТУЧНІ КОНКУРЕНТНІ ПЕРЕВАГИ ЯК ПРИНЦИП ФОРМУВАННЯ НОВОГО МІЖНАРОДНОГО ПОДІЛУ ПРАЦІ

The purpose of the article is to conceptualize climate-technological decoupling as a structurally unique form of international economic decoupling and to substantiate green artificial competitive advantages as a theoretical category that continues the Smith – Ricardo – Krugman – neoprotectionist line of competitive advantage analysis. The conceptual novelty of the article lies in the identification of climate-technological decoupling as a form of decoupling whose regulatory object — the global atmosphere and the total balance of greenhouse gases — is physically indivisible, which radically distinguishes it from all previous

forms (trade, investment, financial, technological) in which the object of decoupling was divisible between contours. This difference in the physical nature of the object creates the paradox of fragmented response: the unified nature of the climate problem is accompanied by a fragmented architecture of political reaction, which exceeds the scale justified by purely climate considerations and is therefore characterized in the article as strategically redundant decoupling.

The article substantiates that the actual content of climate-technological decoupling is the revision of the international division of labour through the construction of green artificial competitive advantages — regulatory, financial, and technologically designed advantages in green sectors that do not reflect natural resource endowments or historically accumulated capabilities but are the product of political action. Green artificial competitive advantages are substantiated as the fourth stage in the evolution of concepts of competitive advantages, following classical absolute advantages, Ricardian comparative advantages, Krugman's strategic advantages, and neoprotectionist artificial advantages. A principled feature of green artificial competitive advantages that distinguishes them from previous forms is their dual legitimation, in which the climate goal and the industrial-competitive function are inseparably combined within a single instrument. Four interconnected channels of the formation of green artificial competitive advantages are identified: regulatory stringency, subsidy architecture, technological standards, and rules of financial access. Regulatory sandboxes are interpreted as a specific instrument of temporal asymmetry that complements the structural asymmetry of the four channels. The article analyzes the emergence of new technological dependencies within decoupled green value chains as a structural consequence that transforms the green transition from a decarbonization initiative into a space of systemic reconfiguration of global resource dependencies.

Метою статті є концептуалізація кліматично-технологічного декаплінгу як структурно унікальної форми міжнародного економічного

декаплінгу і обґрунтування зелених штучних конкурентних переваг як теоретичної категорії, що продовжує лінію аналізу конкурентних переваг від смітівського і рікардіанського підходів до кргуманівського й неопротекціоністського. Концептуальна новизна статті полягає у виявленні кліматично-технологічного декаплінгу як форми декаплінгу, об'єкт регулювання якої - глобальна атмосфера і сукупний баланс парникових газів - фізично неподільний, що радикально відрізняє її від усіх попередніх форм (торговельний, інвестиційний, фінансовий, технологічний), у яких об'єкт декаплінгу був поділюваним. Така відмінність у фізичній природі об'єкта породжує парадокс фрагментованої відповіді: єдиний характер кліматичної проблеми супроводжується фрагментованою архітектурою політичної реакції, яка перевищує масштаб, обґрунтовуваний суто кліматичними міркуваннями, і тому характеризована у статті як стратегічно надлишковий декаплінг.

У статті відзначено, що фактичним змістом кліматично-технологічного декаплінгу є перегляд міжнародного поділу праці через конструювання зелених штучних конкурентних переваг - регуляторно, фінансово і технологічно сформованих переваг у зелених секторах, які не випливають із об'єктивно заданої ресурсної бази чи історично сформованого виробничо-технологічного потенціалу, а є результатом цілеспрямованої політичної дії. Зелені штучні конкурентні переваги обґрунтовано як четвертий етап еволюції концепцій конкурентних переваг, який продовжує лінію класичних абсолютних переваг, порівняльних переваг Д. Рікардо, стратегічних переваг П. Кругмана і неопротекціоністських штучних переваг. Принциповою ознакою зелених штучних конкурентних переваг, яка відрізняє їх від попередніх форм, є подвійна легітимація, у якій кліматична мета і промислово-конкурентна функція нерозрізнювано поєднані у межах одного інструменту. У статті виявлено чотири взаємопов'язані канали формування зелених штучних конкурентних переваг: регуляторна жорсткість, архітектура субсидій, технологічні стандарти і правила

фінансового доступу. Регуляторні пісочниці інтерпретовано як специфічний інструмент темпоральної асиметрії, що доповнює структурну асиметрію чотирьох каналів. У статті проаналізовано виникнення нових технологічних залежностей у межах декаплінгованих зелених ланцюгів як структурний наслідок, що перетворює зелений перехід з декарбонізаційної ініціативи на простір системної реконфігурації глобальних ресурсних залежностей.

Keywords: *policy of development restraint, competition, asymmetry, standardization, sustainability, fragmentation, institutionalization, international division of labor, decoupling, climate-technological decoupling, green value chains, competitive advantages, green division of labor, neoprotectionism, climate policy, industrial policy, regulatory sandboxes, subsidies, rare earth elements, CBAM, climate change, EU, USA, PRC*

Ключові слова: *політика стримування розвитку, конкуренція, асиметрія, стандартизація, сталість, фрагментація, інституціоналізація, міжнародний поділ праці, декаплінг, кліматично-технологічний декаплінг, зелені ланцюги вартості, конкурентні переваги, зелений поділ праці, неопротекціонізм, кліматична політика, промислова політика, регуляторні пісочниці, субсидії, рідкісноземельні елементи, CBAM, кліматичні зміни, ЄС, США, КНР*

Introduction. In recent years, green value chains - from the extraction of critical minerals and the production of batteries to the manufacture of solar panels, wind turbines, electric vehicles, and green hydrogen technologies - have been undergoing an active reconfiguration, the scale of which goes far beyond the limits of natural market processes. Investment flows into green sectors are redistributed along politically determined routes; production capacities are transferred not to regions with the best climatic conditions for solar generation or with the most efficient carbon profile of production, but to jurisdictions determined by regulatory decisions; critical segments of technological chains are undergoing a conscious demarcation between blocks with different political configurations. The process,

which in the international economic literature is described as “climate-technological decoupling”, takes on a form that goes beyond purely technological or environmental issues and requires theoretical understanding in the categories of the international division of labor and strategic rivalry.

Previous studies of trade, investment, financial, and technological decoupling have formed a significant analytical apparatus, but climate-technological decoupling demonstrates characteristics that are not reducible to the forms already described. The specificity of climate-technological decoupling begins with a fundamental fact: the object of climate policy regulation in the ultimate sense - the global atmosphere and the balance of greenhouse gases - is not physically divided. Greenhouse gases do not distinguish between jurisdictions, do not stop at borders, and do not concentrate over the territories of their emitters. The collective good of climate stabilization is strictly global in nature. This fact creates a fundamental analytical tension with what is actually observed in regulatory practice: instead of a single global carbon pricing system, a single taxonomy of sustainable activities and a single system of emissions verification, a multiplicity of parallel regulatory spaces has been formed, and instead of integrated global supply chains of green technologies, closed blocks are being formed, each of which is building its own production in critical segments.

The dominant reading of this process in the scientific literature interprets decoupling in green chains as a rational strategy to reduce the vulnerability of critical supplies, a necessary component of green industrial policy, or a technical response to the challenge of decarbonization. The problem with such a reading is that it does not explain the scale of the phenomenon. If the goal is to reduce global emissions as efficiently as possible, a rational economic strategy would be to produce green technologies where they are most efficient in terms of carbon intensity, cost and speed of capacity expansion, with the result then being shared through open trade. The real practice is moving in the opposite direction: the European Union (EU) Net Zero Industry Regulation, the EU Critical Raw Materials Regulation, the United States (US) Inflation Reduction Act with its localization requirements, and the People’s Republic of China’s (PRC) dual carbon policy all set domestic production targets that exceed the purely climate-optimal

ones. This excess of decoupling requires a theoretical explanation that cannot be reduced to climate rationality.

The research hypothesis underlying this article is that climate-technological decoupling is not a technical response to the climate challenge, but an independent economic and political process of revising the international division of labor, in which the climate imperative serves as a legitimizing framework for constructing new competitive advantages. These advantages are not natural - they do not reflect resource endowments, climatic conditions, or historically accumulated capabilities. They are constructed by political action through regulatory, financial, and technological channels. To theoretically describe this phenomenon, a category of green artificial competitive advantages is proposed, which fits within the tradition of analyzing competitive advantages in the international economy, represented by the Smith-Ricardo-Krugman line and neo-protectionist artificial advantages, and constitutes the fourth stage of this analytical line. The relevance of such an interpretation is due to the need for a theoretical explanation of the structural nature of the rearrangement of green value chains and the development of adequate conceptual tools for economies that are faced with the need to simultaneously comply with the criteria of the green transition and maintain strategic autonomy in determining their own development path.

The review of the literature. The theoretical and methodological basis of the study is formed at the intersection of geoeconomic and climate discourses, which allows for interpreting climate policy as a tool for structurally reformatting the international division of labor. The works of S. Arslan reveal the strategic role of economic instruments in global politics [1] and the evolution of climate diplomacy as an independent dimension of international relations [2], which creates the basis for their integrated analysis.

The conceptualization of the policy of development restraint as a regulatory and institutional regime that shapes the development trajectory of a systemic competitor is presented in [3], where the de-risking and decoupling policies are also distinguished. Decoupling as a tool for reconfiguring production and technological relations is substantiated in [12]. Methodological approaches to assessing the stringency of environmental regulation were proposed by C. Brunel

and A. Levinson [4], and the conceptual foundations of the green economy were formulated by K. Burkart [5] and developed by V. Chala and Yu. Orlovska [6]. The connection between environmental impact and the creation of added value in global supply chains was proven by R. Clift and L. Wright [7]. The theoretical foundations of neoprotectionism as a tool for creating artificial competitive advantages are disclosed in [8], while the classical-liberal interpretation of the international economic order is presented by R. Sally [9]. The issues of global asymmetries and new centers of economic growth are highlighted in [10; 11].

The institutionalization of EU climate policy and the effects of decarbonization are investigated in [13], and the evolution of the policy and its legal instruments are systematized in [14–17]. A critical analysis of the carbon border adjustment mechanism is presented in [18], which demonstrates its limited effectiveness. The development of approaches to ecological modernization and institutional mechanisms of sustainability is reflected in [19–21], while the issues of global development, economic growth strategies, and post-war recovery are systematized in [22–24]. The combination of these approaches allows us to consider "green value chains" and climate-technological decoupling as the basis for a new architecture of the international division of labor through "green artificial competitive advantages".

The purpose of the article. The purpose of the article is to conceptualize climate-technological decoupling as a form of international economic decoupling, to provide a theoretical justification for green artificial competitive advantages, and to interpret regulatory sandboxes as a tool for temporal asymmetry and new technological dependencies as a structural consequence of decoupling.

The main material of the article. Understanding climate-technological decoupling involves generalizing the forms of international economic decoupling and identifying their common structural feature. Trade, investment and financial decoupling involve the delimitation of commodity, capital and financial flows between national economies or integration blocks with a reorientation to alternative partners, while technological decoupling in the classical sense, systematized in [13], means limiting the circulation of critical technologies, semiconductor components and access to sensitive segments of the technological

stack; they are united by the divisibility of the object, which allows for the formation of relatively autonomous economic ties.

Climate-technological decoupling has a fundamental characteristic, since its object is the global atmosphere and the total balance of greenhouse gases, which are physically indivisible, as a result of which, even under the conditions of delimitation of green value chains between individual countries or technological blocks, emissions remain interconnected, and the climate system responds to their total volume, which forms a structural asymmetry between the divisibility of economic mechanisms and the indivisibility of the physical object and determines the specifics of this type of decoupling (Table 1).

Table 1. Forms of international economic decoupling in a comparative dimension

Form of decoupling	Object of decoupling	Physical nature of the object	Typical tools	Typical examples
Trade decoupling	Trade flows between economies	Shared	Tariffs, anti-dumping measures, trade restrictions	TUS-China trade confrontation since 2018
Investment decoupling	Direct and portfolio investment	Shared	Restrictions on inbound and outbound investments, screening	Restrictions on Chinese investments in the critical infrastructure of the US and the EU
Financial decoupling	Financial ties, foreign exchange reserves, settlements	Shared	Limitations on mutual debt withholdings, sanction settlement regimes, and alternative payment infrastructures	Sanction regimes against the Russian Federation starting in 2022, restrictions on settlements in US dollars
Technological decoupling	Technological artifacts, research collaborations	Shared	Export controls on critical technologies, restrictions on scientific exchanges	Restrictions on semiconductor exports to China, restrictions on research collaborations
Climate and Technology Divergence	Global Atmosphere and Carbon Balance (Formal); Green Value Chains (Operational)	Physically Indivisible (Object) with a Divisible Operational Mechanism	CBAM, IRA Localization Requirements, Fragmented Sustainability Taxonomies, Different Carbon Accounting Standards	Parallel Regulatory Spaces of the EU, the US, and China in Green Sectors

Source: compiled by the authors

The physical indivisibility of the object of climate-technological decoupling gives rise to a structural feature - the paradox of the fragmented response. Its content is that the unified nature of the climate problem is accompanied by a fragmented architecture of the political response: the object is single, while the response is

multiple. This anomaly has two possible interpretations. The first is “coordination”: fragmentation is a temporary dysfunction resulting from the failure of multilateral coordination and must be eliminated through greater global coordination. The second is “functional”: fragmentation performs an independent function that is not reducible to a coordination failure, and that explains its persistence despite many years of attempts to overcome it. The second interpretation follows from an analysis of the strategic redundancy of decoupling. The volume and intensity of decoupling in green value chains observed in recent years significantly exceed levels justified solely by climate goals. If the goal is to minimize global emissions over a given horizon, a rational strategy involves producing green technologies where they are most efficient in terms of carbon intensity, cost, and the speed of capacity expansion, with the results shared through open trade. The real practice is moving in the opposite direction: the Inflation Reduction Act (IRA) sets local production requirements for subsidies, regardless of whether local production is more carbon-efficient than imported production; the EU’s Clean Zero Industry Regulation and Critical Raw Materials Regulation set targets for intra-European production that exceed the purely climate-optimal ones; and China is developing closed production loops in segments where global integration would provide faster and cheaper decarbonization. The quantitative characteristics of these restrictions (40% domestic production in strategic green technologies under the EU Regulation, 60% origin of components from the US or trading partners under the IRA, etc.) exceed the level justified by the carbon-efficiency calculation.

Other manifestations of decoupling that go beyond the climatically determined ones are referred to as strategically redundant decoupling. This redundancy is not the result of a mistake or inefficiency; it performs an independent function - the redistribution of positions in the international division of labor. This function is not a side effect of climate policy; it constitutes its real, although formally undeclared, content. It is precisely strategic redundancy that explains why the paradox of a fragmented response persists despite the obvious coordination inefficiency: for the declared climate goal, fragmentation is a

dysfunction, whereas for the redistribution function, it is a necessary condition. A single global regulatory system would deprive jurisdictions with regulatory power of the very instrument through which redistribution is implemented. This reveals the structural connection between climate-technological decoupling and a broader policy of development containment: as with other regulatory and institutional instruments, the process's content is not a situational correction of the competitor's behavior, but the formation of long-term development asymmetries.

We use the category of green artificial competitive advantages as a theoretical framework to explain the operational mechanism by which climate policy redistributes positions in the international division of labor. The category of green artificial competitive advantages continues the tradition of analyzing competitive advantages in the international economy, tracing its stages along the line of "Smith's concept of absolute advantages" - "Ricardo's concept of comparative advantages" - Krugman - neo-protectionist artificial advantages. In the classical tradition, competitive advantage was interpreted as an objective characteristic that existed independently of political will.

P. Krugman in the new trade theory of the 1980s showed that in conditions of imperfect competition, scale effects, external learning effects, and experience curves, the state can purposefully create competitive advantages through strategic trade policy, investment in key sectors, and support for national producers. This was the first theoretical recognition that competitive advantages can be the product of political action, rather than a natural process, although the link to sectors in which scale and learning effects created objective economic grounds for strategic policy was maintained. The theory of neo-protectionism deepened this reading, showing that modern forms of protectionism are mainly not based on classical customs barriers, but are implemented through technical regulations, standards, certification procedures, sanitary and phytosanitary requirements - that is, through the construction of artificial competitive advantages by regulatory means. Neo-protectionist artificial advantages have become the third stage of the analytical line: they are no longer connected with natural resources (as classical ones), are not limited to supporting objectively

promising sectors (as strategic ones), but are constructed through a thin fabric of regulatory instruments that do not formally violate the principles of free trade. Green artificial competitive advantages constitute the fourth stage of this analytical line. Unlike classical comparative advantages, they do not reflect natural resource endowments or historically accumulated capabilities. Unlike neo-protectionist artificial advantages, they have a unique feature: a dual legitimation based on both climate and industrial goals. It is this dual legitimation that constitutes a qualitative difference of the new stage. Any attempt to challenge green artificial competitive advantages as discriminatory comes up against a legitimate reference to a climate goal, which has the moral authority of global collective action. Any attempt to reduce them to purely climate policy runs up against their obvious industrial and competitive consequences. This mutual neutralization of arguments makes green artificial competitive advantages a particularly persistent tool in international trade relations. A general relationship between the stages of evolution of the concept of competitive advantage is presented in Table 2.

Table 2. Evolution of concepts of competitive advantage in the international economy

Concept	Nature of benefits	Source	Role of the state	Climate dimension
Absolute advantages (A. Smith, 1776)	Natural	Relative productivity across sectors	Minimal, ensuring open trade	None
Comparative advantages (D. Ricardo, 1817)	Natural/ historical	Relative productivity across sectors	Minimal, ensuring open trade	Missing
Strategic advantages (P. Krugman, 1980s)	Constructed	Scale effects, learning effects, externalities, support for key sectors	Active, strategic trade policy	Not articulated
Neoprotectionist artificial advantages (late 20th - early 21st centuries)	Constructed	Technical regulations, standards, certification procedures, SPS requirements	Constructive, through non-tariff regulatory instruments	As one of several legitimizing dimensions
Green artificial competitive advantages (2020s)	Constructed	Regulatory rigidity, subsidy architecture, technological standards, and financial access rules	Comprehensive, through a combination of climate and industrial instruments; dual legitimation	Central legitimizing dimension

Source: compiled by the authors

Structurally, green artificial competitive advantages are formed through four interconnected channels that operate synchronously and mutually reinforce one another, creating a complex regulatory and institutional architecture. The first channel is regulatory rigidity. Setting high sustainability standards serves a dual function: first, it protects the internal market from external participants who are unable to meet them due to limited resources, technologies, or time for adaptation; second, it establishes a compliance premium for domestic producers who have had time to adapt or are prepared for these standards in advance. The EU Sustainability Taxonomy, Corporate Sustainability Reporting Directive (CSRD), and Corporate Sustainability Due Diligence Directive (CSDDD) do not formally discriminate by origin, but in fact, they create entry barriers that can be overcome mainly by participants with a developed institutional reporting and compliance infrastructure.

The second channel is subsidy architecture. Financial incentives tied to local production or the origin of components change the competitive landscape without formal trade restrictions. The IRA provides tax credits only to manufacturers whose components originate in the United States or in countries with relevant trade agreements; this tie is not formally a trade barrier, but it, in fact, redirects global investment flows into green sectors to the United States. A similar function is performed by subsidy mechanisms within the EU's Net Zero Industry Regulation, as well as sectoral subsidy programs in the PRC tied to the national production chain. The third channel is technological standards. Setting technical requirements that reflect the technological profile of domestic manufacturers creates a structural advantage for those whose technology meets them and imposes additional costs on external participants who must adapt. EU battery standards under the Batteries and Battery Waste Regulation, green hydrogen standards under the Renewable Hydrogen Delegated Regulation (2023), and product standards under the CBAM require external manufacturers to make significant additional investments to achieve compliance. The fourth channel is financial access rules. Tying access to green finance to compliance with domestic taxonomies deprives manufacturers from other jurisdictions of the opportunity to compete for investment resources on

a level playing field. Financing conditions under the European Investment Bank, the European Recovery and Sustainability Fund, and the Strategic Technology Platforms for Europe (STEP) create access rules based on domestic regulatory criteria.

The four-channel structure of the formation of green artificial competitive advantages is complemented by a specific tool that has not received sufficient attention in the context of climate policy in classical regulatory analysis: regulatory sandboxes. In the classical interpretation, a regulatory sandbox is a limited experimental space in which pilot technologies are tested with a temporary relaxation of some regulatory requirements. The classical function of sandboxes is to give new technologies the opportunity to develop to regulatory maturity without excessive regulatory barriers that inhibit innovation at the early stages. In the modern architecture of climate policy, regulatory sandboxes acquire another function - the function of asymmetric experimentation. Leading jurisdictions create regulatory sandboxes for their own green technologies - new types of batteries, green hydrogen technologies, carbon capture and storage systems, modular small nuclear reactors, promising materials for solar generation - which allows them to be brought to industrial maturity in a relaxed regulatory regime. Examples include regulatory sandboxes within the EU's Net Zero Industry Act, Horizon Europe, separate national pilot regimes for hydrogen projects in Germany and the Netherlands, and pilot experimental zones for new energy technologies in China.

At the same time, these same jurisdictions continue to apply full regulatory rigidity to external entrants offering functionally similar technologies. The structural consequence is the creation of an additional time interval during which domestic technologies gain first-mover advantage, while external technologies, upon reaching regulatory maturity, are confronted with established technical standards anchored to the parameters of domestic solutions. Regulatory sandboxes, in this sense, function as a mechanism of temporal asymmetry that complements the structural (spatial) asymmetry of the four channels of green artificial competitive advantage formation. If the four channels create differences in the

positions of domestic and external entrants at a given point in time, then regulatory sandboxes create differences in the speed with which domestic and external entrants can reach technological maturity. The combined effect of both types of asymmetry - spatial and temporal - provides a sustainable architecture of advantages that is not reduced to a one-time barrier but is reproduced through constant preemption.

An important structural consequence of the formation of green artificial competitive advantages is the emergence of new technological dependencies within decoupled green chains. This consequence paradoxically characterizes climate-technological decoupling as a self-dynamic process that goes beyond its declared goals. The transition to electric vehicles, solar and wind generation, and energy storage creates a dependence on critical minerals (lithium, cobalt, nickel, copper, and graphite), rare-earth elements (neodymium, dysprosium, terbium, and praseodymium), semiconductor components, and battery technologies.

The geographical concentration of extraction and processing of these resources structurally reproduces new asymmetries in the global economy: instead of a single dependence on oil and gas, a mosaic of several critical dependencies forms, each concentrated in a few jurisdictions. Lithium - mainly Chile, Australia, Argentina; cobalt - the Democratic Republic of Congo; rare earth elements - the PRC (about 60% of extraction and over 85% of processing); processing capacity for battery materials - the PRC and South Korea; solar panel production - over 80% of global capacity in the PRC. This configuration means that decoupling in green chains does not eliminate dependencies, but replaces some dependencies with others, and the new dependencies are often more concentrated in a few jurisdictions than the previous ones.

This situation paradoxically actualizes green decoupling as a self-threat: the jurisdictional architects who set the rules for decoupling simultaneously remain dependent on suppliers of critical resources, creating a tension between the strategy of autonomy and the realities of the technological chain. The result is a spiraling increase in regulatory constraints aimed at reducing dependencies that were

themselves generated by previous decisions on decoupling - confirming the self-dynamic nature of the process. The EU Critical Raw Materials Regulation, adopted in 2024, sets targets for domestic extraction (10% of annual consumption), processing (40% of annual consumption), and recycling (15% of annual consumption) for strategic critical raw materials. These targets are not justified by climate rationality (recycling and reducing dependencies will certainly have environmental benefits, but the scale of the targets does not follow from the climate calculation) - they are justified by the logic of strategic autonomy. Thus, climate-technological decoupling is transforming from a decarbonization initiative into a space for the systemic reconfiguration of global resource dependencies, thereby reproducing and reinforcing the international asymmetries it was originally intended to mitigate.

Conclusions. Climate-technological decoupling constitutes a structurally unique form of international economic decoupling, which differs from previous forms (trade, investment, financial, technological) in that the object of regulation - the global atmosphere - is physically single and indivisible, while the political response is fragmented into multiple parallel regulatory spaces. This structural inconsistency, conceptualized as the paradox of the fragmented response, is not a temporary coordination dysfunction; it is a constitutive element of the modern architecture of climate policy, a necessary condition for the existence of competitive positions in green sectors constructed by regulatory means. The volume and intensity of decoupling exceed the level justified by purely climate goals, allowing it to be characterized as strategically redundant and indicating the presence of an independent function of redistributing positions in the international division of labor through the climate imperative as a legitimizing framework. The fundamental feature of green artificial competitive advantages, which distinguishes them from previous forms, is a dual legitimation, in which the climate goal and the industrial-competitive function are indistinguishably combined within a single instrument. This dual legitimation ensures the unique stability of green artificial

competitive advantages as a regulatory mechanism and complicates their challenge by neutralizing arguments against them.

The four-channel structure of the formation of green artificial competitive advantages - regulatory rigidity, subsidy architecture, technological standards, and financial access rules - reveals the systemic nature of the structure, which is not reduced to individual regulatory acts, but constitutes a complex regulatory and institutional architecture. Each of the four channels operates according to its own logic, but in interaction with the others creates an effect that is not reduced to the sum of individual influences. Regulatory sandboxes, as tools of temporal asymmetry, complement the spatial asymmetry of the four channels and provide a sustainable architecture of advantages that is not reduced to a one-time barrier but is reproduced through the constant outpacing of external participants in achieving technological maturity.

The emergence of new technological dependencies within decoupled green chains is a structural consequence of climate-technological decoupling, which transforms it from a decarbonization initiative into a space for systemic reconfiguration of global resource dependencies. Decoupling does not eliminate dependencies, but replaces some dependencies with others, and new dependencies in the areas of critical minerals, rare earth elements, processing capacities are often more concentrated in a few jurisdictions than the previous ones. This creates a spiral of regulatory constraints aimed at reducing dependencies that were themselves generated by previous decoupling decisions - confirming the self-dynamic nature of the process. For economies that are not among the leading architects of the new regulatory order, the practical significance of the proposed framework lies in understanding the structural nature of green artificial competitive advantages as a prerequisite for strategic positioning in green value chains.

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