

DIGITAL TRANSFORMATIONS AS A DRIVER OF CHANGES IN SOCIO-ECONOMIC DEVELOPMENT: CONTRADICTIONARY AND ASYMMETRIC CHARACTER OF DIGITAL DEVELOPMENT AND THE DIGITAL RECONFIGURATION OF ECONOMIC SECURITY

ЦИФРОВІ ТРАНСФОРМАЦІЇ ЯК ДРАЙВЕР ЗМІН У СОЦІАЛЬНО-ЕКОНОМІЧНОМУ РОЗВИТКУ: СУПЕРЕЧЛИВИЙ І АСИМЕТРИЧНИЙ ХАРАКТЕР ЦИФРОВОГО РОЗВИТКУ ТА ЦИФРОВА РЕКОНФІГУРАЦІЯ ЕКОНОМІЧНОЇ БЕЗПЕКИ

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Abstract. *The purpose of the article is to substantiate the theoretical interpretation of digital transformations as a contradictory and asymmetric driver of socio-economic development that penetrates all traditional dimensions of economic security and converts digital security and cybersecurity into its constitutive mechanisms, and to demonstrate that the balance between strengthening and undermining economic security is determined not by technologies as such but by the configuration of regulatory and institutional frameworks of digital security, cybersecurity, and antimonopoly policy. The article proposes a conceptual framework that interprets digital transformation not as a linear modernization process but as a permanent multi-vector restructuring that penetrates the food, energy, and financial dimensions of economic security from within, transforming them through digital tools and platforms, with the consequence that traditional dimensions of economic security cannot be analytically separated from the digital contour without losing the substance of the analysis. The thesis of the contradictory and asymmetric character of*

digital development is substantiated, according to which the same technological foundation simultaneously expands the space of market opportunities and produces new forms of concentration of economic power, with benefits concentrated in a narrow circle of actors and risks dispersed across a broad base of participants, which transforms the question of the overall impact of digitalization on socio-economic development into a question of differentiated analysis of distributional outcomes for various groups of actors. Digital competition is analysed as a meta-mechanism of redistribution of economic power through such forms as platform competition, coopetition, escalation model, and algorithmic collusion, which together form a new matrix of threats to economic security and require a fundamental rethinking of antimonopoly policy. Digital stratification is examined as an endogenous factor that undermines economic security from within the national economic space through the erosion of the tax base, labour market, consumer demand, and fiscal capacity of the national state, while digital agents and artificial intelligence are interpreted as a new frontier of systemic risks of economic security that require the formation of international mechanisms of risk management going beyond the traditional regulatory toolkit.

Keywords: *socio-economic development, global transformations, economic security, transformation, digitalization, digital divide, digital inequality, digital security, cybersecurity, digital competition, digital stratification, digital agents, artificial intelligence, coopetition*

Анотація. *Метою статті є обґрунтування теоретичної інтерпретації цифрових трансформацій як суперечливого й асиметричного драйвера соціально-економічного розвитку, що проникає в усі традиційні виміри економічної безпеки й перетворює цифрову безпеку та кібербезпеку на її конститутивні механізми, а також демонстрація того, що баланс між зміцненням і підривом економічної безпеки визначається не технологіями як такими, а конфігурацією регуляторно-інституційних рамок цифрової безпеки, кібербезпеки та антимонопольної політики. У статті пропонується концептуальна рамка, яка інтерпретує цифрову трансформацію не як лінійний процес модернізації, а як перманентну багатовекторну реструктуризацію, що проникає в продовольчий, енергетичний і фінансовий виміри економічної безпеки зсередини, трансформуючи їх через цифрові інструменти та платформи, унаслідок чого традиційні виміри економічної безпеки не можуть бути аналітично відокремленими від цифрового контуру без втрати суттєвості аналізу. Обґрунтовується теза про суперечливий і асиметричний характер цифрового розвитку, згідно з якою одна й та сама технологічна основа одночасно розширює простір ринкових можливостей і продукує нові форми концентрації економічної влади, причому вигоди концентруються у вузькому колі акторів, тоді як ризики розосереджені по широкій базі учасників, що перетворює питання про загальний ефект цифровізації на соціально-економічний розвиток у питання диференційованого аналізу розподільчих наслідків для різних груп акторів. Цифрова конкуренція проаналізована як метамеханізм перерозподілу економічної влади через такі форми, як платформна конкуренція, коопетиція, ескалаційна модель та алгоритмічна колюзія, що разом формують нову матрицю загроз економічній безпеці й потребують фундаментального переосмислення антимонопольної політики. Цифрова стратифікація розглядається як ендегенний чинник, що підриває економічну безпеку зсередини національного економічного простору через ерозію податкової бази, ринку праці, споживчого попиту та фіскальної спроможності національної держави, а цифрові агенти й штучний інтелект інтерпретуються як новий рубіж системних ризиків економічної безпеки, що потребують формування міжнародних механізмів управління ризиками, які виходять за межі традиційного регуляторного інструментарію.*

Ключові слова: *соціально-економічний розвиток, глобальні трансформації, економічна безпека, трансформація, цифровізація, цифровий розрив, цифрова нерівність, цифрова безпека, кібербезпека, цифрова конкуренція, цифрова стратифікація, цифрові агенти, штучний інтелект, конкуперация.*

Introduction. *Over the past three decades, digital transformation has evolved from the status of an industry-wide technological process to a fundamental condition for economic reproduction, while simultaneously undergoing a qualitative change in its nature from a tool for increasing productivity to an independent mechanism that determines the trajectory of socio-economic*

development, the configuration of economic security, and the architecture of international economic relations. As a result, the traditional theoretical apparatus of economic science, formed mainly in the logic of the industrial economy, is increasingly unsuitable for adequately describing the qualitative shifts in the conditions of platform capitalism and the algorithmic economy. Modern research shows that digital transformation has gone far beyond the introduction of individual technologies into production processes and has taken on the character of a systemic structural shift that encompasses all levels of economic organization, from the microlevel of individual enterprises to the megalevel of global production networks and geopolitical relations, and this shift is accompanied by the formation of new types of economic subjectivity, new models of competition, and new forms of economic power that fundamentally modify the mechanisms of socio-economic development (*Panchenko & Oliinyk, 2025a*). What is fundamentally important in this context is that digital tools have penetrated each of the traditional spheres of economic reproduction, namely food, energy, and finance, transforming them from within and thereby changing the very architecture of economic security, as a result of which none of the traditional dimensions of economic security today can be ensured without a reliable digital circuit, and any failure in this circuit immediately translates into a failure of the entire security architecture of the national economy. The thesis of digital transformation as a universal tool for expanding access to economic opportunities, widespread in public discourse and partly in academic works, is increasingly encountering empirical counterarguments, including the growth of productivity in the digital sector against the backdrop of stagnant median incomes in most developed economies, the concentration of market capitalization within a narrow group of BigTech corporations at historically unprecedented levels, and the polarization of the employment structure between high-paying cognitive-digital positions and low-paid platform employment, which generally indicates the asymmetric nature of the distribution of digital benefits and risks among different groups of actors (*Panchenko & Oliinyk, 2025b; Brynjolfsson, Chandar & Chen, 2025*). The digital divide, which for a long time was interpreted as a transitional phenomenon that was supposed to be automatically overcome as infrastructure spread, is taking on the features of a stable structural property of the global economy, reproducing and reinforcing traditional forms of inequality in the new technological envelope, and this process is especially clearly manifested in the dimension of intergenerational differences in the perception of new threats to economic security, where the generation that was formed in the conditions of an already formed digital reality demonstrates a qualitatively different matrix of perception of digital risks and digital inequality from previous generations (*Reznikova, Chugaiev, Bulatova & Ptashchenko, 2023*).

The working hypothesis of the study assumes that digital transformations function not as a neutral driver of socio-economic development, but as a mechanism that, through digital competition and platform dominance, simultaneously expands the space of market opportunities and produces new forms of concentration of economic power, digital inequality, and systemic risks. Moreover, a fundamentally important point in this hypothesis is the proposition that digitalization does not create a separate, parallel dimension of economic security, but penetrates all its traditional dimensions, food, energy, and financial, transforming them from the inside, as a result of which digital security and cybersecurity become not parallel categories, but constitutive mechanisms of economic security as a whole. The specific balance between strengthening and undermining economic security is set not by technologies as such, but by the configuration of the regulatory and institutional frameworks of digital security, cybersecurity, and antitrust policy, and the contradictory and asymmetric nature of digital development means that benefits and risks are distributed unevenly among actors, forming new mechanisms of digital stratification that translate traditional socio-economic inequality into its digital forms and, at the same time, generate fundamentally new axes of stratification that are uncharacteristic of the industrial economy. The study's relevance stems from several interrelated factors that together justify the need to rethink the conceptual apparatus for analyzing the relationship between digital transformations and economic security. First, the traditional categorical apparatus of economic security, built on the paradigm of the industrial economy with its clear separation of food, energy and financial dimensions, is becoming less and less suitable for assessing the qualitative shifts caused by the digital transformation of traditional dimensions of security, since the digital circuit permeates all these dimensions and unites them into a new systemic integrity, which requires an appropriate methodological design.

Second, traditional instruments of competition policy and social protection demonstrate a decrease in effectiveness in response to new forms of market power, platform dominance, and labor relations in the platform economy, which actualizes the need to form preventive regulatory mechanisms and conceptually new approaches to managing digital competition (*Reznikova, Bulatova, Panchenko & Ivashchenko, 2023*). Third, the accelerated development of autonomous artificial intelligence systems and digital agents capable of making economically significant decisions independently creates a fundamentally new category of economic security risks that has not yet received adequate theoretical and regulatory formulation and is a focus of modern economic theory and policy. Fourth, Russia's war against Ukraine has demonstrated with unprecedented clarity that cybersecurity of critical infrastructure is not an abstract technological category, but an existential dimension of economic security, closely connected with the energy, financial and food reproduction of the national economy, and the specific Ukrainian experience provides unique empirical material for verifying theoretical propositions about the constitutive role of the digital circuit in the functioning of traditional dimensions of economic security.

The purpose of the article is to substantiate the theoretical interpretation of digital transformations as a contradictory and asymmetric driver of socio-economic development that penetrates all traditional dimensions of economic security and turns digital security and cybersecurity into its constitutive mechanisms, as well as to form a holistic conceptual framework for analyzing a new matrix of threats to economic security that is being formed in the context of digital transformations, digital competition, algorithmic collusion, and autonomous digital agents. The methodological basis of the study is a theoretical and analytical approach, which relies on structural and functional analysis to reveal the contradictory and asymmetric nature of digital development and institutional analysis to study the relationship between technological changes and regulatory and political frameworks, and these approaches are complemented by a comparative and historical method to compare modern digital transformation with previous technological revolutions and identify its qualitative specificity, as well as a systemic approach to describe the relationship between traditional and digital dimensions of economic security within a single conceptual framework.

Literature review. Modern research on digital transformations forms several powerful scientific directions, each of which reveals individual aspects of the multidimensional process and at the same time, leaves room for further theoretical synthesis, and the need for an integrative understanding of the relationship between digital transformation and traditional dimensions of economic security, which so far remains mostly fragmentary and has not formed a coherent conceptual framework, is especially palpable. The first direction is related to the conceptualization of digital transformation as a technological paradigm that redefines the foundations of production, exchange and consumption, with an emphasis on platform business models, network effects and the ecosystem nature of the digital economy, within which it is justified that platformization is not just an organizational innovation, but a fundamental reconfiguration of economic relations, in which digital platforms are transformed into quasi-institutional structures that form the rules of interaction between market participants, control access to information flows and extract a significant part of the value created, while simultaneously functioning as markets, production systems and regulatory authorities, which blurs the traditional analytical boundaries between these categories and requires a rethinking of the very concept of an economic institution (*Panchenko & Oliinyk, 2025a; Panchenko & Oliinyk, 2025c; Panchenko & Oliinyk, 2025d; Reznikova, Ptashchenko & Ptashchenko, 2025*).

An important analytical perspective is also offered by studies of the nature of power in digital capitalism, which demonstrate that the large-scale accumulation of behavioral data by large digital corporations gives rise to a fundamentally new form of economic power, based on the ability to predict and modify user behavior, rather than simply serving their preferences, resulting in a specific asymmetry between data generators and their monetizers, which reproduces the traditional logic of capitalist exploitation in a new technological shell (*Zuboff, 2019*).

A separate scientific direction focuses on the impact of automation and artificial intelligence on the labor market, incomes, and macroeconomic dynamics, and within this direction, a robust analytical foundation has been established for studying the structural shifts driven by digital transformations (*Acemoglu & Restrepo, 2018*). The development of this analytical perspective demonstrates that the macroeconomic consequences of AI critically depend on whether existing tasks

are largely automated or new productive opportunities are created, which shapes the trajectory of productivity, employment, and income distribution and determines whether the digital transformation leads to inclusive development or increases inequality (*Acemoglu, 2024; Brynjolfsson, Chandar & Chen, 2025; Eloundou, Manning, Mishkin & Rock, 2024; Trammell & Korinek, 2023; Shahidi, Rusak, Manning, Fradkin & Horton, 2025*). Empirical analyses record a correlation between the spread of generative artificial intelligence and the growth of unemployment in relevant professional groups, which indicates the observed effects of technological substitution in modern labor markets (*Ozkan & Sullivan, 2025*), while studies of the extreme risks of artificial intelligence in conditions of accelerated progress emphasize the need to form institutional mechanisms for managing these risks, which go beyond the traditional regulatory tools and require international coordination (*Bengio et al., 2024*).

Digital competition research is another significant academic area directly related to the issue of economic security, since the configuration of competitive relations in the digital age directly determines the distribution of economic power between market players and between jurisdictions, and therefore the configuration of threats and opportunities for national economic security. Conceptual works demonstrate how artificial intelligence affects economic development strategies, income distribution, and global economic dynamics through the prism of international political economy and technological change, emphasizing the specific challenges for developing countries that risk finding themselves in a state of persistent digital dependence in the new technological hierarchy (*Korinek, 2024; Korinek & Stiglitz, 2021; Calvano, Calzolari, Denicolò & Pastorello, 2020*). Research on the framework for the development of the digital sector focuses on the regulatory, infrastructural and institutional challenges of digitalization, which require a comprehensive approach to digital policy formation (*Assad, Clark, Ershov & Xu, 2024; OECD, 2024; World Economic Forum, 2025b; International Energy Agency, 2025*). Despite the development of individual research areas, significant theoretical gaps remain in the existing literature, justifying the need for further theoretical synthesis.

Main results of the research. The traditional perception of digital transformation as a technological renewal of production processes turns out to be reductionist and does not correspond to the scale and qualitative nature of the changes taking place, since digital transformation today is a permanent process of fundamental restructuring of economic, social, institutional and cultural practices, which simultaneously encompasses several vectors of movement and does not have a clearly defined end point, as a result of which attempts to describe digital transformation as a completed modernization process encounter the structural impossibility of such a description. The first vector, technological, is associated with the evolution of digital infrastructure through several qualitatively different generations, each of which not only added new tools, but redefined the very structure of economic interactions, moving from static web pages and email through social networks and interactive platforms to decentralized technologies, artificial intelligence systems and autonomous agents, and the pace of technological change within this vector tends to accelerate, which complicates institutional adaptation and forms a permanent gap between technological capabilities and regulatory frameworks.

The second vector, institutional, concerns the transformation of rules, norms, and practices regulating economic activity, characterized by the interaction of two mechanisms of institutional change, namely bottom-up processes initiated by startups, entrepreneurs, and new services that outpace existing regulatory frameworks, and top-down processes driven by states, supranational regulators, and BigTech corporations that shape standards and rules. The balance between these mechanisms changes across different stages of digital economy development, shifting from the predominance of bottom-up dynamics in the early stages to the strengthening of top-down regulation at more mature stages. The third vector, structural, is manifested in the formation of new sectors of the economy, new types of markets and new business models that gradually replace or transform traditional economic structures, forming a new structural architecture of national and global economies. The fourth vector, anthropological, consists in the transformation of the very nature of the economic subject, since along with traditional individuals and legal entities, digital agents appear, that is, algorithmic systems capable of autonomous economic decision-making, which raises a fundamental question about the limits of economic subjectivity in the algorithmic era (*Shahidi, Rusak, Manning, Fradkin & Horton, 2025*). Fundamentally important for understanding the socio-economic

consequences of digital transformation is that it does not unfold as an external factor in relation to the economy, but penetrates all spheres of economic reproduction, transforming them from the inside, and this nature of penetration leaves no sphere outside the digital contour, and therefore makes it impossible to analyze any aspect of the modern economic system without taking into account its digital dimension.

The central theoretical construct of the study is the concept of the contradictory and asymmetric nature of digital development, the essence of which is that one and the same technological basis simultaneously generates two groups of effects that are in a complex relationship, and do not simply coexist in parallel, and understanding this relationship is a necessary prerequisite for an adequate analysis of the socio-economic consequences of digitalization and the formation of effective economic policy. The inclusive potential of digitalization is manifested in the fact that digital platforms reduce the transaction costs of entering markets, giving small producers, freelancers and small businesses access to a global audience that was unattainable in the pre-digital era, while digital educational resources formally expand access to knowledge, allowing people from resource-limited regions to obtain qualifications, while digital financial services expand financial inclusion for groups traditionally excluded from the banking system, giving the impression of a universal democratizing dynamic of digitalization, which supposedly leads to an automatic reduction of inequality and an expansion of opportunities. However, the same mechanisms also generate exclusionary effects, and not as accidental side effects, but as structural features of the same technological architecture, which fundamentally distinguishes the digital era from previous waves of technological change, in which exclusionary effects could be seen mainly as transitional costs of modernization.

Platforms that lower barriers to entry for small players simultaneously concentrate unprecedented market power in the hands of a few global gatekeepers who dictate the terms of access, pricing, and profit sharing, a concentration that tends to be self-reinforcing through network effects, economies of scale, and first-mover advantages, creating a winner-take-all structure in which even a small initial advantage can turn into absolute dominance. Fundamentally important in this concept is the asymmetric nature of the distribution of digital effects: benefits are concentrated in a narrow circle of actors, while risks and transaction costs are dispersed across a wide base of participants, which means that the contradictions of digital development are realized precisely as an asymmetry of distribution, and not as a symmetric collision of two equilibria in which inclusive and exclusive effects would balance each other. Such structural asymmetry means that the question of the general effect of digitalization for socio-economic development cannot be resolved in a generalized manner and requires a differentiated analysis of different groups of actors, and the specific balance between inclusive and exclusive effects is determined not by technologies as such, but by the configuration of the regulatory, institutional and political-economic frameworks in which digital transformation unfolds, which shifts the focus of economic policy from the technological to the institutional level and raises the question of the adequacy of the existing institutional frameworks to the challenges of the digital era.

Digital transformations do not create a separate, parallel dimension of economic security alongside the traditional ones, but penetrate each of them, transforming them from within, as a result of which economic security in the digital era is not the sum of the old dimensions plus the new digital one, but is the result of the digital reconfiguration of the traditional dimensions of security themselves, namely food, energy, and financial. Food security in the digital age is mediated by digital harvest aggregation platforms, algorithmic weather forecasting systems, precision agriculture based on the Internet of Things, digital supply chains, and exchange-based pricing algorithms on commodity markets, as a result of which a failure in any of these digital circuits becomes a failure of food security, and a cyber threat to an agricultural holding or algorithmic manipulation on commodity exchanges is not a digital problem in addition to the food problem, but the very form of existence of modern food vulnerability, which fundamentally changes the nature of food sector risks and requires a rethinking of food security tools. Energy security in the digital age even more clearly demonstrates this constitutive role of the digital circuit, as energy systems are managed by dispatching control and data collection systems, smart grids, and algorithmic dispatching, as a result of which an attack on digital energy supply systems is an attack on energy security, and the Ukrainian experience of war demonstrates this with unprecedented clarity, since cyberattacks on critical energy infrastructure have

become one of the key tools of economic and military pressure, and energy security today is impossible without cybersecurity of critical infrastructure, and these categories merge to the point of indistinguishable in the practical dimension of ensuring national economic sustainability (*International Energy Agency, 2025*).

Financial security in the digital age is fully mediated by digital technologies, including online banking, financial technologies, payment systems, algorithmic trading, cryptocurrencies, and artificial intelligence-based risk assessment models. As a result, algorithmic collusion in financial markets, digital manipulation, and cyberattacks on banking systems are not a complement to financial security, but the main channel for its potential destabilization. Moreover, the cross-border nature of digital financial flows means that the financial security of national economies depends on decisions and events beyond national jurisdiction. Such a constitutive role of the digital circuit in the functioning of traditional dimensions of economic security means that digital security and cybersecurity cannot be considered as autonomous technological categories or as a parallel circuit added to economic security, since they are internal mechanisms of the functioning of economic security itself, its constitutive dimensions, without which traditional dimensions of security cannot be ensured in principle, and any failure in the digital circuit immediately translates into a failure of the entire architecture of economic security. A fundamentally important conclusion from this provision is that investments in digital security cease to be technological costs and acquire the status of strategic investments in national economic security, and digital sovereignty, that is, the ability of a country to independently determine the rules for the development of the digital economy on its own territory, becomes a key component of economic sovereignty as a whole, which actualizes the need to form a holistic national digital strategy that integrates economic, security and technological dimensions.

In the context of digital transformations, competition ceases to be one of the elements of economic development along with other mechanisms and turns into a meta-mechanism of redistribution of economic power, which directly affects the configuration of economic security, since structural shifts in the competitive environment of the digital economy directly change the balance of power between actors and between jurisdictions. Digital competition has several fundamental differences from traditional competition that require theoretical understanding in view of their implications for economic security. First, the objects of competition undergo a fundamental change, because if in the industrial economy the main objects were factors of production, market share and price advantage, then in the digital economy data as a strategic resource, consumer attention as a limited resource and innovation as a condition for survival come to the fore, and control over these resources directly correlates with control over the economic security of national economies (*Reznikova, Ptashchenko & Ptashchenko, 2025*). Secondly, forms of digital competition are acquiring a fundamentally new character, which requires a separate analysis. Platform competition is a mixed type of interaction in which participants simultaneously cooperate and compete within the same ecosystem, and the boundaries between horizontal and vertical competition, between global and local levels, between competition and cooperation are blurred, which complicates the application of traditional antitrust regulation tools and requires the formation of a new concept of competitive analysis adequate to the ecosystem nature of digital markets. Coopetition, that is, simultaneous competition and cooperation between digital market entities, forms a new model of market behavior in which companies share risks and costs of innovation, jointly enter new markets or adhere to common standards, while maintaining a competitive struggle for the end consumer, and such coopetition strategies are becoming the dominant form of interaction in many segments of the digital economy and are creating new challenges for antitrust policy, since traditional tools are unable to adequately distinguish between pro-competitive and anti-competitive forms of coopetition.

The escalating model of competition is manifested in the fact that digital giants are forced to constantly invest in research and development, marketing and capital expenditures in order to maintain their market position, while the temporal structure of competition is compressed to weeks, and competitive advantage tends to rapidly depreciate without constant innovation, which forms a new type of market dynamics with increased barriers to entry for new participants and structural advantages for players with the largest capital for constant investments. A particularly important form of digital competition from the perspective of economic security is algorithmic collusion, that is,

autonomous coordination of pricing and other market strategies between algorithmic systems without explicit programming for collusive behavior, and such a phenomenon arises as an emergent property of machine learning systems and is not reducible to traditional forms of price collusion (*Calvano, Calzolari, Denicolò & Pastorello, 2020; Assad, Clark, Ershov & Xu, 2024*). Algorithmic collusion constitutes a fundamentally new form of market failure, as it arises not as a result of an explicit conspiracy between economic entities, but as an emergent property of machine learning systems, which complicates its detection and regulation within the framework of traditional antitrust tools and creates a new category of threats to economic security, especially in the financial, energy and food segments, where algorithmic pricing is becoming increasingly widespread. The combination of these forms of digital competition forms a new matrix of threats to economic security, in which the concentration of market power in the hands of digital giants means that the economic security of national economies becomes a function of decisions made outside national jurisdiction, which actualizes the need for the formation of preventive regulatory mechanisms and international coordination of antitrust policy (*Reznikova, Karp & Ivashchenko, 2023*).

Digital stratification is an endogenous factor that undermines economic security within the national economic space, reproducing and reinforcing traditional forms of socio-economic inequality within the new technological envelope and, at the same time, generating fundamentally new axes of stratification uncharacteristic of the industrial economy. In contrast to the traditional concept of the digital divide with its predominantly binary opposition of access or lack of access, digital stratification describes a multidimensional structure of persistent gaps in the digital sphere, which are translated into socio-economic stratification and are mutually reinforcing, forming a vicious circle of exclusion, which, without targeted institutional intervention, tends to be self-reinforcing. The infrastructural dimension of digital stratification captures unequal access to digital infrastructure, from broadband internet and computing power to data centres and the energy resources to support them, and this gap is evident at all levels, from the international level, with a characteristic concentration of cloud infrastructure in a narrow range of countries, to the intra-national level, with gaps between cities and rural areas. The competence dimension expresses inequality in digital skills, and a feature of this dimension is its cumulative nature, since those who have basic skills have a higher chance of developing advanced ones, while those who do not have access to basic education in the digital sphere risk falling into the trap of being undemanding in the labour market, which forms persistent trajectories of economic exclusion (*World Economic Forum, 2025a*). The dimension of data control captures the inequality between the subjects who generate data, i.e. mainly users of digital services, and those who collect, analyze and monetize it, i.e. platforms and corporations, and this dimension is particularly problematic because it reproduces the asymmetry of economic rent, in which the value created through the generation of data by billions of users is concentrated in a narrow circle of digital corporations (*Zuboff, 2019*). The algorithmic dimension expresses inequalities in the ability to understand, challenge, or influence algorithms that make economically significant decisions, with algorithmic opacity becoming a new form of institutional power, especially over vulnerable groups that lack the resources for algorithmic literacy. The regulatory dimension captures inequalities across jurisdictions in their ability to shape the rules of the game for the digital economy, generating a specific form of regulatory dependency for countries with lower institutional capacity (*Panchenko & Oliinyk, 2025b*). A separate axis of digital stratification, which is gaining increasing research attention, is the intergenerational dimension, within which different generations demonstrate qualitatively different matrices of perception of digital threats and digital inequality, and generation Z, which was formed in the conditions of an already established digital reality, demonstrates a specific structure of digital vulnerability and digital competencies, which differs from previous generations and gives rise to a specific form of Z-inequality in the context of the formation of a digital society (*Reznikova, Chugaiev, Bulatova & Ptashchenko, 2023*). Digital stratification undermines economic security through several channels, including the erosion of the tax base due to the exclusion of significant groups from the full digital economy, the destabilization of the labor market due to a structural shift in the demand for competencies, the reduction of consumer demand due to the concentration of digital rents in a narrow circle of actors, the weakening of the fiscal capacity of nation states due to the evasion of global digital corporations from taxation in the jurisdictions of their operations, as well as the formation of a new geography of economic inequality due to the spatial

concentration of digital benefits in narrow cores with simultaneous displacement from the periphery, which threatens the territorial integrity of national economic spaces (*Panchenko & Oliynyk, 2025a*).

Digital agents and artificial intelligence form a new frontier of economic security, which requires a rethinking of the very concept of an economic subject and the category of systemic risks, since the traditional tools of economic theory and regulatory policy did not foresee the existence of autonomous non-biological participants in economic processes capable of independently making economically significant decisions. Along with traditional individuals and legal entities, algorithmic systems are emerging in the economy that are capable of autonomously making economic decisions, ranging from forecasting market conditions and optimizing production processes to independently concluding contracts and managing investment portfolios, and the scale and autonomy of such systems are growing exponentially, forming a fundamentally new configuration of economic relations (*Shahidi, Rusak, Manning, Fradkin & Horton, 2025*). The emergence of digital agents as functional participants in economic processes raises several fundamental questions for the theory of economic security, each of which requires a separate theoretical and regulatory formulation.

First, the issue of attribution of responsibility, since when an economically significant decision is made by an algorithmic system, the problem arises of determining the entity responsible for the consequences of this decision, especially in cases where the consequences turn out to be destructive for individual market participants or for the system as a whole, and the traditional legal categories of attribution of responsibility did not provide for such a situation and require significant adaptation. Secondly, the issue of predictability and controllability: complex artificial intelligence systems, especially those that learn, can exhibit emergent behavior not foreseen by their developers, creating a fundamentally new category of systemic risks that are difficult to address with traditional risk management (*Bengio et al., 2024*). Third, the issue of the concentration of algorithmic power, as the development and control of the most powerful AI systems are concentrated in a narrow circle of companies and countries, creates an asymmetry of algorithmic influence on the global economy and creates a new axis of international economic dependence that overlaps with and reinforces the existing structures of the global economic hierarchy. Fourth, the issue of labor substitution, as AI-based automation demonstrates the ability to affect a wide range of cognitive professions, which shapes structural shifts in labor markets and requires a rethinking of social protection instruments and employment policies (*Acemoglu, 2024; Brynjolfsson, Chandar & Chen, 2025; Eloundou, Manning, Mishkin & Rock, 2024*). A common feature of the risks posed by digital agents and artificial intelligence for economic security is their systemic and cross-border nature, since a failure or abuse in artificial intelligence systems can have cascading consequences that spread through the digital infrastructure to all sectors of the economy regardless of national borders, and such cross-border nature limits the effectiveness of national regulatory instruments and highlights the need to form international mechanisms for managing artificial intelligence risks, which so far remain fragmented and do not form a coherent architecture of global digital security.

Conclusions. The conducted research allows us to substantiate several fundamentally important theoretical propositions that form a holistic conceptual framework for the analysis of digital transformations as a driver of socio-economic development and a factor in the reconfiguration of economic security, and these propositions together form an integrative theoretical model that combines the economic, institutional and security dimensions of digitalization. First, digital transformations constitute a permanent multi-vector process that encompasses technological, institutional, structural and anthropological dimensions that are in a complex relationship and cannot be reduced to any of them separately, and this process does not unfold as an external factor in relation to the economy, but penetrates into all spheres of economic reproduction, transforming them from the inside, which makes it impossible to analyze any aspect of the modern economic system without taking into account its digital dimension. Secondly, digital transformations have a contradictory and asymmetric nature, which is not a transitional characteristic, but a built-in structural property of digital development, since the same technological basis simultaneously expands the space of market opportunities and produces new forms of concentration of economic power, with benefits concentrated in a narrow circle of actors, while risks and transaction costs are dispersed across a wide base of participants, which means the need for a differentiated analysis of the distributional consequences of digitalization for different groups of actors and a shift in the focus of economic

policy from the technological to the institutional level, since the specific balance between inclusive and exclusionary effects is determined not by technologies as such, but by the configuration of the regulatory and institutional framework.

Thirdly, a fundamentally important conclusion of the study is that digital transformations do not create a separate, parallel dimension of economic security, but penetrate all its traditional dimensions, food, energy and financial, transforming them from the inside, as a result of which digital security and cybersecurity become not parallel categories, but constitutive mechanisms of economic security as a whole, without which traditional dimensions of security cannot be ensured in principle. Investments in digital security cease to be technological costs and become strategic investments in national economic security, and digital sovereignty becomes a key component of economic sovereignty, underscoring the need to form a holistic national digital strategy that integrates economic, security, and technological dimensions. Fourth, digital competition becomes a meta-mechanism for the redistribution of economic power, which directly affects the configuration of economic security through such forms as platform competition, coopetition, the escalation model, and especially algorithmic collusion, which constitutes a fundamentally new form of market failure and a new category of threats to economic security, requiring a revision of the traditional antitrust toolkit and the formation of preventive regulatory mechanisms adequate to the emergent nature of algorithmic coordination.

Fifth, digital stratification constitutes an endogenous factor undermining economic security from within the national economic space through such channels as the erosion of the tax base, the destabilization of the labor market, the reduction of consumer demand, the weakening of the fiscal capacity of nation states, and the formation of a new geography of economic inequality, with a special axis of digital stratification being the intergenerational dimension, in which different generations demonstrate qualitatively different matrices of perception of digital threats and digital inequality. Sixth, digital agents and artificial intelligence form a new frontier of economic security, which requires a rethinking of the very concept of an economic entity and the category of systemic risks, and their systemic and cross-border nature actualizes the need to form international risk management mechanisms, which so far remain fragmentary and do not form a coherent architecture of global digital security.

Further research should focus on several interrelated areas that together form a promising research program in the field of the relationship between digital transformations and economic security. The first area involves the development of methodological tools for measuring the multidimensional structure of digital stratification, which would allow us to quantitatively assess its impact on economic security and analyze its dynamics over time, with special attention being paid to the operationalization of categories such as digital stratification, digital sovereignty, digital rent, and algorithmic power, which so far remain predominantly qualitative concepts. The second direction covers the analysis of the effectiveness of various regulatory models in mitigating the negative effects of digital competition, with a special emphasis on a comparative study of European, American and Asian approaches to regulating digital markets and platforms and their implications for national economic security, and such an analysis should form the basis for the formation of best practices in regulating the digital economy in the context of national specificities. The third direction is related to the formation of a strategic framework for digital sovereignty as a component of economic sovereignty for countries with an intermediate status in the global digital hierarchy, which would combine economic, security and technological dimensions and take into account the specifics of national conditions, limited resources and the need for integration into global digital processes. The fourth direction involves deepening the theoretical analysis of risks associated with autonomous digital agents and artificial intelligence systems, and the formation of adequate regulatory and institutional mechanisms for managing these risks at the national and international levels, which is one of the most complex and urgent tasks of modern economic theory and policy.

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