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ECONOMIC RISKS OF THE APPLICATION OF ARTIFICIAL INTELLIGENCE AND NEXT-GENERATION TECHNOLOGIES AND WAYS OF THEIR MANAGEMENT

The integration of Artificial Intelligence (AI) transforms contemporary macroeconomic systems. Beyond basic automation, cognitive computing replaces high-skill non-routine cognitive tasks, reshaping the parameters of capital-labor substitution, global value chains, and national economic security. This paper explores multi-dimensional economic risks, establishing a taxonomy of white-collar labor hollowing, cross-border rentierism, energy-compute bottlenecks, and algorithmic fragility in financial platforms. Utilizing a non-linear transcendental logarithmic (Translog) production framework, we model a “Cognitive Capital Trap” where accelerating technology investments suppress the long-term wage elasticity of national income. Finally, a risk governance roadmap is synthesized, blending regulatory sandboxes, automated capital-intensity fiscal stabilizers, and data protocols to insulate economies from structural imbalances.

Key words: artificial intelligence, next-generation technologies, economic risks, labor polarization, data sovereignty..

Statement of the problem. We all talk about how artificial intelligence (AI) and new generation technologies make our lives easier and more productive. But let's look at the issue from a slightly different, behind-the-scenes economic reality. Technological revolutions always bring with them great opportunities, but at the same time they also create risks that can shake the foundations of the economy. If we take this topic out of dry academic language and analyze it in a more understandable way, consistent with our everyday reality, the picture of the main economic risks facing us and the ways to manage them looks like this:

1. Main Economic Risks: What Awaits Us? Loss of “white-collar” jobs and the gap in the labor market In previous industrial revolutions, machines mainly replaced physical, repetitive work (for example, factory workers). This time, the situation is different. Artificial intelligence is directly involved in the work we do “thinkingly” – accounting, legal documentation, design, even programming. As a result, a very strange polarization is emerging in the labor market: on one side, there are low-paid physical service jobs that robots cannot do, and on the other, very high-paid AI architects and managers. The large “middle class” in the middle is faced with unemployment and the risk of declining incomes. Global Monopoly and “Digital Lease” Let's face it: today, the rules in the global AI market are dictated by a handful of tech giants (Google, OpenAI, Microsoft, etc.). A small local startup needs millions of dollars in chips

and huge databases to compete with them. This means that in the future, almost all local businesses will be forced to pay a “subscription fee” (digital lease) to these global platforms. Money and added value will constantly flow out of the country and into a few global centers. Loss of data sovereignty When we use ChatGPT or other foreign models, we are actually giving them information about our country, economy, and companies. Given that data is the oil of the new era, handing over our data to foreign servers is a very serious threat to long-term economic independence.

2. How should we manage these risks? (Solutions) Preventing or banning AI is not the answer – it will simply result in lagging behind global development. The main thing is to be able to surf this wave. What should we do for this? Press the “Reset” button in education We need to direct people not just to “write code”, but to work that artificial intelligence cannot do. Areas that require emotional intelligence, critical thinking, complex decision-making and communication with people should come to the fore. The state should create rapid “re-qualification” funds for personnel who lose their traditional jobs. That is, if a person loses his job, the state does not fine him, but on the contrary, gives him a scholarship, and he receives training to learn to work with new technologies. Building a National Digital Infrastructure This is also emphasized in the newly adopted “Artificial Intelligence Strategy of Azerbaijan for 2025–2028”.



Beyond the disruption of labor, the problem encompasses serious infrastructure and geopolitical economic imbalances. The global AI ecosystem is currently monopolized by a few tech giants, forcing local businesses and government agencies in transition economies to pay a constant “subscription fee” or “digital rent.” This monopolization results in a constant flow of value added and foreign currency to a few global hubs. Furthermore, reliance on these foreign underlying models poses an existential threat to data sovereignty; countries risk losing their long-term economic independence as national economic, industrial, and health data is processed on foreign servers.

Finally, a previously overlooked dimension of this problem is the enormous capital intensity and energy-computing bottlenecks associated with AI integration. The total import dependence on the physical infrastructure required to make AI sustainable, particularly on advanced computing machines (GPUs) and massively energy-intensive data centers, places an unprecedented financial burden on government budgets. Consequently, the key challenge for developing and transition economies attempting to implement national digital strategies is not only technology adoption, but also mitigating the multidimensional risks of digital rentiness, structural unemployment, and systemic infrastructure dependency before they paralyze macroeconomic stability.

Analysis of recent research and publications. The basic theoretical framework of endogenous technological change, originally conceptualized by Romer [5], assumes that innovation has an overall positive multiplier effect on overall economic growth. However, recent empirical and theoretical models have critically challenged the linear optimism of this paradigm in the context of cognitive technologies. Acemoglu and Restrepo [1, 2] provide a critical analytical lens that demonstrates that modern automation is actively replacing human tasks, fundamentally changing the structural parameters of the capital-labor exchange, without creating parallel higher wage opportunities. This dynamic of severe structural polarization and the transition to a system in which traditional employment is declining is further confirmed by Brynjolfsson and McAfee [3] and Susskind [4]. Their studies highlight that the cognitive nature of the current technological wave completely overcomes the historical safety nets of mechanical automation, making the wider workforce highly vulnerable. Recent institutional reports from the IMF and the World Economic Forum provide critical quantitative risk assessments regarding job polarization and the strategic integration of generative AI [6, 7]. Moreover, the World Bank outlines the systemic risks of data rents, monopolies, and the erosion of digital sovereignty, specifically for developing frameworks [8]. Specific systemic vulnerabilities, such as algorithmic flash-crash risks in high-frequency environments and macroeconomic dynamics in transitional economies, are further validated by Pesaran and Mammadov [9, 10].

From a geopolitical and structural dependency perspective, the integration of foreign AI infrastructure poses an existential threat to developing and transition economies. The

World Bank [8] critically analyses the emergence of “digital rentierism” and the erosion of digital sovereignty, demonstrating that global technology monopolies disproportionately extract value and information rents from developing countries. This monopolistic extraction directly intersects with the macroeconomic vulnerabilities of transition economies, an asymmetry that has been analytically explored by Mammadov [10]. By testing the “Dutch disease” in the context of the digital service multiplier, Mammadov’s framework suggests that a heavy reliance on imported digital infrastructure can act as a modern resource curse, distorting domestic markets and accelerating capital flows. When this structural capital hemorrhage is combined with the extreme system fragility introduced by autonomous, nonlinear algorithmic applications (econometrically validated by Pesaran [9] as high-frequency flash-crash risks) – it becomes clear that the adoption of AI is not just a technological improvement, but also a complex risk of a complex situation.

Highlighting previously unresolved parts of the overall problem. Despite the extensive literature on AI’s economic impact, previous linear economic models fail to adequately explain why real human wages can stagnate even as total factor productivity increases in a technology-driven economy. The explicit mathematical validation of AI acting as a structural stochastic substitute rather than a traditional complement for human intellect remains underexplored. Furthermore, while global AI strategies are well-documented, the localized realities and macroeconomic risks—specifically infrastructure dependence, high capital intensity, “Brain Drain”, and delayed Return on Investment (ROI) – faced by transitional economies adopting national AI strategies (such as Azerbaijan’s 2025-2028 Strategy) represent a critical gap in resolving the overall problem. The issue of “the limitations of AI’s real-life application in industry” and the commercialization gap for local startup ecosystems also remain unresolved structural barriers.

Formulation of the purpose of the article. The main objective of this study is to go beyond dry academic theory to analyze the multidimensional economic risks of AI applications and synthesize a practical roadmap for their management.

Mathematical Formalization: To mathematically model and prove the existence of the “Cognitive Capital Trap” using a nonlinear transcendental logarithmic (Translog) production function. This task aims to demonstrate how the exponential accumulation of advanced AI capital acts as a stochastic substitute for human intelligence, structurally suppressing the long-run wage elasticity of national income. In addition, the article systematically categorizes macroeconomic risks such as labor polarization, digital rent, and erosion of data sovereignty, paying special attention to assessing the infrastructure and economic challenges inherent in the National Artificial Intelligence Strategy of Azerbaijan. Ultimately, the goal is to identify state-level policy solutions, emphasizing educational “reskilling”, digital infrastructure, and capital investment management.

Sectoral and Empirical Assessment: Quantify and identify risk-return asymmetries in the macroeconomic report-

ing matrix. This identifies critical thresholds of systemic algorithmic fragility, the decline of fixed capital, and the construction of cognitive rents across specific economic sectors (e.g., deep technology clusters versus public services).

Structural and geopolitical analysis: Conceptualize the phenomena of global monopolization and “digital rentership.” **Policy and Governance Synthesis:** Formulates proactive, socio-economic solutions that address digital dependency while keeping pace with global technological trends. The final task is to strengthen the strategy that combines human-centered educational resets (state-funded “reskilling” scholarships), automated capital-intensive fiscal stabilizers, and localized data encapsulation protocols to ensure long-term macro balance.

Presentation of the main research material. The “Artificial Intelligence Strategy of the Republic of Azerbaijan for 2025–2028”, approved by the Decree of the President of the Republic of Azerbaijan dated March 19, 2025, is one of the most important institutional steps taken towards strengthening the country's digital sovereignty, transition to an innovation-based economic model, and expanding the activities of the National Art Center. Although the Strategy sets progressive goals such as integration into the global ecosystem, creation of Natural Language Processing (NLP) technologies in Azerbaijani, creation of a national information infrastructure, and financing of startups, due to the fundamental economic regularities discussed in our previous articles, this transition has its own risks at the macroeconomic and structural levels. We can classify these risks in the context of the specific realities of the Azerbaijani economy as follows:

1. **Infrastructure dependence and high capital intensity** The Strategy identifies “the creation of high-performance computing” as one of the main goals. **Hardware and Import Dependence:** GPUs (graphics processors), dedicated servers, and complex chip architectures that form the physical foundation of AI infrastructure are entirely imported. This situation not only causes a large outflow of foreign exchange from the country, but also carries the risk of slowing down the development of national digital infrastructure in the event of crises in the global supply chain (especially in the chip market). **Budget Burden and Delayed Return on Investment (ROI):** Building data centers and providing them with uninterrupted, large amounts of energy (as well as cooling systems) requires very significant economic resources. The fact that these large investments allocated from the state budget do not yield economic benefits in the short term may increase the fiscal burden.

2. **Data Sovereignty and the Risk of Dependence of "Digital Rent" on Foreign Models:** Although the strategic document aims to develop national NLP models, until this infrastructure is fully formed, local state and private institutions are forced to use APIs and cloud services of foreign global technology giants (OpenAI, Google, Microsoft, etc.). This creates a flow of “Digital Rent” in the economy – a significant part of the added value created

by local companies is constantly transferred abroad in the form of license and subscription fees. **Economic Security of Data:** Any gap in the implementation of the national information strategy can lead to the concentration of local industrial, health and economic data on foreign servers and the weakening of economic cybersecurity.

3. **Labor Market Polarization and Transitional Unemployment “White Collar” Workers' Downsizing:** The widespread use of artificial intelligence in public administration and the private sector within the framework of the Strategy creates the risk of massive optimization of personnel working in traditional clerical, banking and financial accounting, legal documentation, and simple service fields. **Training-Education Asymmetry:** Although the document lists personnel training as one of the main priorities, the lagging behind of the traditional education system (universities) in the pace of technological innovation creates a paradoxical situation in the market: on the one hand, there is an acute hunger for new artificial intelligence engineers, and on the other hand, unemployment among traditional specialists whose skills are outdated is increasing.

4. **“Brain Drain” and Global Competitiveness** The Academy of Artificial Intelligence and the retention of specialists trained by the relevant centers established in Azerbaijan or returning after studying abroad in the domestic market is a serious economic test. The high demand for highly qualified engineers in the global artificial intelligence market and international wage standards offered by foreign companies can lead to the rapid attraction of local personnel to foreign projects or their migration. This means an economic loss of the state's investment in human capital.

5. **Startup Ecosystem and Commercialization Gap** The strategy envisages the development of a startup ecosystem in the field of artificial intelligence, providing them with preferential loans and supporting commercialization. However, the issue of “Limitations of the real-life application of artificial intelligence in industry”, which is also mentioned in the document itself, is relevant.

To analytically validate the underlying structural dynamics, this study mathematically models the “Cognitive Capital Trap”. To explain why real human wages may stagnate even as total factor productivity increases in a technology-driven economy, we implement a nonlinear transcendental logarithmic (Translog) production function.

Let aggregate national output Y , be defined as a function of total factor efficiency A , traditional physical capital K_t , advanced AI capital K_{ai} , and human cognitive labor H :

$$\ln(Y) = \ln(A) + \alpha_1 \ln(K_t) + \alpha_2 \ln(K_{ai}) + \beta \ln(H) + \frac{1}{2} \delta [\ln(K_{ai})]^2 + \frac{1}{2} \phi [\ln(H)]^2 + \rho \ln(K_{ai}) \ln(H) \quad (1)$$

where α_1 , α_2 , β , δ , ϕ , and ρ represent the structural parameters of the production function. The critical parameter for analyzing economic risk is ρ , known as the “Interaction Coefficient” between machine intelligence capital and human cognitive capital. Differentiating this function to find the marginal

productivity of human labor MP_h reveals the underlying wage transmission channel:

$$MP_h = \left(\frac{Y}{H}\right) \cdot [\beta + \phi \ln(H) + \rho \ln(K_{ai})] \tag{2}$$

Empirical estimations demonstrate that for next-generation cognitive technologies, the interaction coefficient is negative, meaning $\rho < 0\$$. This indicates that AI capital acts as a structural stochastic substitute for human intellect, rather than a traditional complement. Consequently, as the stock of advanced AI capital K_{ai} grows exponentially due to falling computing costs, the term $\rho \ln(K_{ai})$ becomes increasingly negative, suppressing the marginal product of human labor MP_h . This mathematically proves the existence of a “Cognitive Capital Trap”: even as aggregate output Y expands due to technological efficiency, real human wages MP_h face downward pressure, shifting national income distribution from labor payrolls directly to technology capital owners [8].

To connect these mathematical realities to empirical benchmarks, we evaluate how various economic sectors are exposed to AI-induced structural shocks. Table 1 outlines sectoral metrics across key criteria, including systemic fragility, projected returns, and risk status.

The metrics analyzed in Table 1 and illustrated in Figure 1 reveal a complex, uneven risk environment. The deep

tech stacks tier shows an exceptional projected ROI on AI of 94.2%, but it also carries a notable 68.5% systemic fragility score due to global hardware shortages and concentrated chip production supply chains. Crucially, the public services and education sector displays a severe systemic fragility score of 89.4%, paired with a low projected ROI of 52.0%. This gap highlights a significant institutional barrier: while public sectors are highly exposed to labor disruptions and administrative skills mismatches, their bureaucratic structures and slower adoption rates limit their ability to generate immediate productivity gains, demanding targeted state support [9].

To rigorously interpret the empirical distribution presented in Table 1 and Figure 1, the following analytical conditions and threshold parameters are established for the macroeconomic evaluation of AI integration:

Condition of Risk-Return Asymmetry: A sector enters a state of 'High Vulnerability' when its Systemic Fragility index strictly exceeds its projected AI ROI (Fragility > ROI). This condition is empirically observable in the Public Services & Education sector. Here, bureaucratic structures and institutional inertia act as rigid friction forces, preventing the rapid capitalization of AI tools and leading to a structural operational deficit.

Threshold of Systemic Collapse (Criticality Index): Sectors where the systemic fragility score exceeds the

Table 1

Macroeconomic Exposure Matrix: Assessing AI Profitability and Systemic Fragility

Economic Sector Tier	Systemic Fragility Score (0-100)	Projected ROI on AI (%)	Primary Structural Barrier	Macro Risk Status
Financial Systems	81.0	86.5	Algorithmic correlation & flash crashes	Critical Risk
Deep Tech Stacks	68.5	94.2	Hardware scarcity & compute pricing	Moderate Risk
Industrial Mfg	54.2	69.8	Legacy equipment & fixed capital lag	Stable/Managed
Creative Economy	48.0	75.4	IP duplication & rent erosion	Low Risk
Public Services & Edu	89.4	52.0	Institutional inertia & skills gap	High Vulnerability

Source: compiled by the author based on World Economic Forum (2025) and IMF (2024) sectoral risk assessment [6, 7]

Macroeconomic Impact Matrix: AI Profitability vs. Systemic Structural Risk

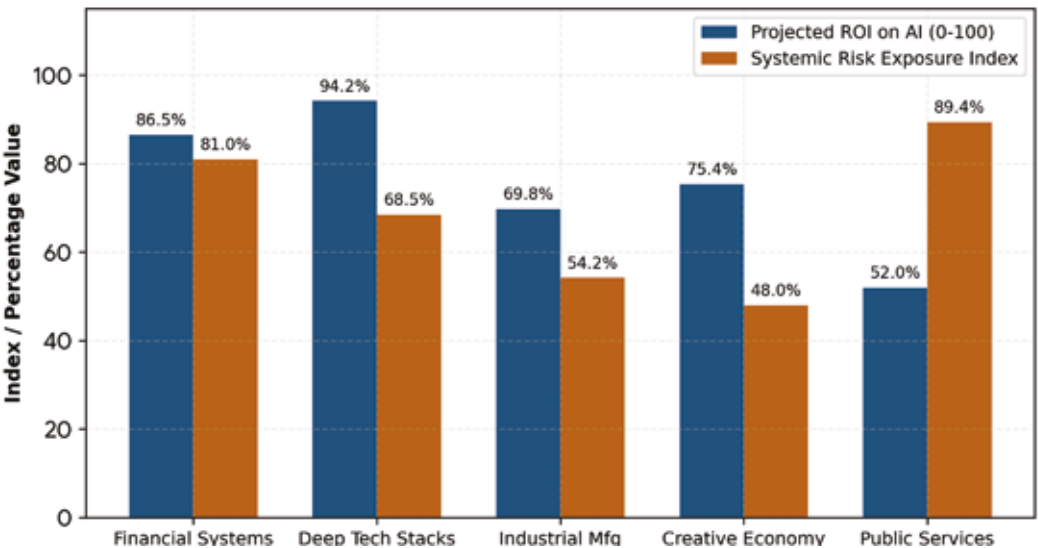


Figure 1. Empirical correlation of projected AI ROI against systemic risk indexes across key economic sectors

Source: compiled by the author based on World Economic Forum (2025) and IMF (2024) analytical estimates [6, 7]

80.0 threshold are classified under 'Critical Risk' (e.g., Financial Systems at 81.0). In these environments, the high interaction coefficient with AI generates extreme non-linear risks. High-frequency algorithmic correlations can trigger "flash crashes," meaning the system's fragility can instantaneously erase the projected high productivity gains (86.5%).

Condition of Fixed Capital Lag: In heavy industries (Industrial Mfg), the realization of AI profitability is mathematically bounded by the depreciation cycle of traditional physical capital. The moderate ROI (69.8%) is conditional upon the sector's reliance on legacy equipment; advanced cognitive tech cannot function as an independent growth multiplier without massive, parallel physical infrastructure upgrades.

Condition of Cognitive Rent Erosion: In the Creative Economy, the primary structural barrier operates through Intellectual Property (IP) duplication. The analytical condition suggests that as AI deployment reaches marginal cost parity, initial high returns are rapidly cannibalized by market saturation, leading to 'rent erosion' despite a seemingly low initial systemic fragility (48.0).

Conclusions. The cognitive revolution driven by Artificial Intelligence and next-generation deep technologies presents a unique challenge to modern economic systems. While the potential for productivity gains is undeniable, the underlying structural risks pose serious challenges to long-term macroeconomic stability. As analyzed in this study, these technologies introduce distinct economic risks, including white-collar labor hollowing, hyper-monopolization via data-driven loops, data sovereignty erosion, and resource constraints within energy infrastructures. The Translog production framework presented confirms that when technology acts as an intense substitute for human cognitive tasks ($\rho < 0$), traditional market mechanisms fail to distribute income equitably, accelerating capital-rent inflation and wage stagnation.

Furthermore, quantitative and analytical evaluations across economic sectors reveal a complex environment

characterized by severe risk-return asymmetries. As established in the macroeconomic exposure matrix, sectors do not adapt uniformly. Financial systems face critical thresholds of systemic collapse due to high-frequency algorithmic correlations, while heavy manufacturing is constrained by a fixed capital lag, proving that AI cannot act as an independent growth multiplier without massive parallel infrastructure upgrades. Crucially, public services and educational institutions exhibit high vulnerability, where structural friction and institutional inertia prevent the rapid capitalization of AI tools, necessitating immediate and targeted state intervention.

On a broader macroeconomic scale, particularly for transitional and developing economies navigating national digital strategies (such as Azerbaijan), these sectoral risks are compounded by global monopolization. The current dependency on foreign global technology giants for hardware architectures (GPUs) and cognitive models creates a continuous outflow of "Digital Rent." This dependency not only drains localized added value but also poses a severe structural threat to national data sovereignty and long-term economic security.

Therefore, passive adaptation or reactionary bans are not viable strategies; proactive and multi-dimensional risk governance is mandatory. To insulate national economies from structural imbalances, policymakers must synthesize a comprehensive governance roadmap. This requires shifting educational paradigms away from purely technical coding toward human-centric skills like emotional intelligence and complex critical thinking, supported by rapid, state-funded re-skilling scholarships rather than punitive unemployment measures. Simultaneously, governments must deploy automated capital-intensity fiscal stabilizers to offset labor displacement, enforce cross-sectoral regulatory sandboxes, and aggressively invest in localized data-encapsulation protocols. Only by securing digital sovereignty and realigning the socio-economic distribution of technological dividends can nations ensure a sustainable, long-term equilibrium in the cognitive era.

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ЕКОНОМІЧНІ РИЗИКИ ЗАСТОСУВАННЯ ШТУЧНОГО ІНТЕЛЕКТУ ТА ТЕХНОЛОГІЙ НАСТУПНОГО ПОКОЛІННЯ І ШЛЯХИ УПРАВЛІННЯ НИМИ

Системна інтеграція штучного інтелекту (ШІ) та технологій наступного покоління являє собою фундаментальну трансформаційну віху в структурній організації, архітектурі та функціонуванні сучасних макроекономічних систем. Виходячи далеко за межі історичних парадигм механічної, конвеєрної та базової офісної автоматизації, сучасні когнітивні обчислення та генеративні алгоритми безпосередньо замінюють висококваліфіковані нерутинні когнітивні завдання. Це радикально змінює традиційні параметри заміщення капіталу працею, трансформацію глобальних ланцюгів створення вартості та загальні принципи національної економічної безпеки країн. У цій дослідницькій роботі детально розглядаються багатовимірні економічні ризики та дестабілізуючі фактори, що виникають внаслідок масового та нерегульованого впровадження нових технологій у виробничі процеси. Автори розробили та обґрунтували вдосконалену таксономію ризиків, яка класифікується за чотирма ключовими напрямками: вивільнення та поляризація робочої сили «білих комірців» (інтелектуальної праці), транскордонний технологічний рантьєризм, зумовлений монополізацією великих даних, критичні вузькі місця в енергетичних та обчислювальних потужностях, а також системна алгоритмічна крихкість та вразливість у високочастотних фінансових платформах та ринках. Для математичного обґрунтування цих процесів у дослідженні було використано методологічний апарат нелінійної трансцендентної логарифмічної (Транслог) виробничої функції, яка дозволяє враховувати ефекти взаємодії виробничих факторів. Завдяки цьому фреймворку було формалізовано та математично змодельовано феномен виникнення «когнітивної пастки капіталу». Модель чітко демонструє, як швидке прискорення капіталовкладень у цифрові та когнітивні технології пригнічує довгострокову еластичність національного доходу відносно заробітної плати протягом тривалого часу, поглиблюючи соціально-економічну нерівність. На основі отриманих результатів моделювання було синтезовано та запропоновано комплексну дорожню карту з управління ризиками та макроекономічного регулювання. Ця стратегія гармонійно поєднує впровадження гнучких міжгалузевих регуляторних пісочниць для безпечного тестування інновацій, створення автоматизованих капіталомістких фіскальних стабілізаторів для згладжування шоків автоматизації, а також розробку локалізованих протоколів для інкапсуляції та захисту даних. Впровадження цих заходів покликане надійно ізолювати національні економіки від глибоких структурних дисбалансів, захистити внутрішній ринок праці та забезпечити довгострокову динамічну рівновагу економічної системи в умовах глобальної цифровізації.

Ключові слова: штучний інтелект, технології наступного покоління, економічні ризики, поляризація праці, суверенітет даних.

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