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ECONOMIC OPPORTUNITIES AND CONSTRAINTS OF ARTIFICIAL INTELLIGENCE ADOPTION IN KAZAKHSTAN'S RESOURCE- ORIENTED ECONOMY

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Abstract. The article explores the economic opportunities and structural constraints of artificial intelligence adoption in Kazakhstan in a resource-oriented economy where extractive industries are a significant part and the level of high-tech diversification is relatively low. The study seeks to assess the potential macroeconomic impact of AI in several areas and to determine the conditions of its contribution to sustainable economic development. A sectoral analytical framework is used, which involves integrating information from the national accounts with AI productivity coefficients from international empirical research. It examines the main sectors of the economy, such as industry, trade, transport, energy, finance, agriculture and health, as well as the communications industry. Emphasis is placed on new technologies like machine learning, deep learning, large language models, and generative AI, which offer further automation and decision support opportunities for various sectors. Under the adopted assumptions, the model-based scenario estimate suggests that the potential economic impact of AI use in Kazakhstan may range between USD 1.6 and 2.59 billion per year, or around 0.9%–1.5% of GDP. This estimate should be interpreted as an indicative scenario-based result derived from international productivity coefficients and Kazakhstan's

sectoral GDP structure, rather than as a direct empirical measurement of the current level of AI adoption by Kazakhstani enterprises. The most substantial potential effect is concentrated in industry, trade, and transport, whereas the contribution of other sectors is more moderate but remains macroeconomically relevant. At the current stage, AI is mainly considered as a tool for efficiency improvement rather than as a driver of structural transformation. The study also highlights crucial constraints, such as a lack of digital infrastructure, human capital, research and development intensity, and reliance on resource-intensive industries. These all limit the diffusion and multiplier effects of AI technologies. It shows the need for policies that are coordinated with respect to technological modernization, education and economic diversification in order to attain the long-term benefits of AI. If left unchecked, AI can exacerbate existing structural imbalances, instead of helping to transition to a knowledge-based economy.

Keywords: Artificial Intelligence, Resource-oriented economy, Economic impact, Machine Learning, Large Language Models (LLMs), Generative AI, Digital transformation

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ҚАЗАҚСТАННЫҢ РЕСУРСТЫҚ БАҒЫТТАЛҒАН ЭКОНОМИКАСЫНА ЖАСАНДЫ ИНТЕЛЛЕКТТІ ЕНГІЗУДІҢ ЭКОНОМИКАЛЫҚ МҮМКІНДІКТЕРІ МЕН ШЕКТЕУЛЕРІ

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Аннотация. Мақалада өндіруші салалар маңызды рөл атқаратын және жоғары технологиялық әртараптандыру деңгейі салыстырмалы түрде төмен Қазақстанның ресурсқа бағдарланған экономикасында жасанды интеллектті (ЖИ) енгізудің экономикалық мүмкіндіктері мен құрылымдық шектеулері қарастырылады. Зерттеудің мақсаты — ЖИ-дің бірқатар салалардағы ықтимал макроэкономикалық әсерін бағалау және оның тұрақты экономикалық дамуға ықпал ету шарттарын анықтау. Зерттеуде ұлттық шоттар деректерін халықаралық эмпирикалық зерттеулерден алынған ЖИ өнімділік коэффициенттерімен біріктіретін салалық аналитикалық тәсіл қолданылады. Өнеркәсіп, сауда, көлік, энергетика, қаржы, ауыл шаруашылығы, денсаулық сақтау және байланыс салалары талданады. Машиналық оқыту, терең оқыту, үлкен тілдік модельдер және генеративтік ЖИ сияқты технологияларға ерекше назар аударылады, өйткені олар автоматтандыру мен шешім қабылдауды қолдаудың жаңа мүмкіндіктерін қалыптастырады. Қабылданған болжамдар негізіндегі модельдік сценарийлік бағалау Қазақстанда ЖИ енгізудің ықтимал экономикалық әсері жылына 1,6–2,59 млрд АҚШ долларын немесе ЖІӨ-нің шамамен 0,9%–1,5%-ын құрауы мүмкін екенін көрсетеді. Бұл көрсеткіш Қазақстан кәсіпорындарындағы ЖИ енгізудің қазіргі деңгейін тікелей эмпирикалық өлшеу ретінде емес, халықаралық өнімділік коэффициенттері мен Қазақстанның салалық ЖІӨ құрылымына негізделген индикативтік сценарийлік нәтиже ретінде қарастырылуы тиіс. Ең жоғары әлеуетті әсер өнеркәсіп, сауда және көлік салаларында шоғырланған, ал басқа секторлардың үлесі салыстырмалы түрде төмен болғанымен, макроэкономикалық маңызын сақтайды. Қазіргі кезеңде ЖИ құрылымдық трансформацияның толыққанды драйверінен гөрі тиімділікті арттыру құралы ретінде көрінеді. Зерттеу цифрлық инфрақұрылымның жеткіліксіздігі, адами капитал шектеулері, ғылыми-зерттеу және тәжірибелік-конструкторлық жұмыстар қарқындылығының төмендігі, сондай-ақ ресурсты көп қажет ететін салаларға тәуелділік сияқты негізгі кедергілерді анықтайды. Бұл факторлар ЖИ технологияларының таралуын және олардың мультипликативтік әсерін шектейді. Алынған нәтижелер ЖИ-дің ұзақ мерзімді артықшылықтарын іске асыру үшін технологиялық жаңғырту, білім беру және экономиканы әртараптандыру салаларында үйлестірілген саясат қажет екенін көрсетеді. Цифрлық инфрақұрылым, адами капитал және экономиканы әртараптандыру бағыттарындағы қосымша шараларсыз ЖИ енгізу білімге негізделген экономикаға өтуді жеделдетудің орнына қолданыстағы құрылымдық теңгерімсіздіктерді күшейтуі мүмкін.

Түйін сөздер: жасанды интеллект; ресурсқа бағдарланған экономика; экономикалық әсер; машиналық оқыту; үлкен тілдік модельдер (LLM); генеративтік жасанды интеллект; цифрлық трансформация

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ЭКОНОМИЧЕСКИЕ ВОЗМОЖНОСТИ И ОГРАНИЧЕНИЯ ВНЕДРЕНИЯ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В РЕСУРСНО- ОРИЕНТИРОВАННОЙ ЭКОНОМИКЕ КАЗАХСТАНА

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Аннотация. В статье рассматриваются экономические возможности и структурные ограничения внедрения искусственного интеллекта (ИИ) в ресурсно-ориентированной экономике Казахстана, где значительную роль играют добывающие отрасли, а уровень высокотехнологичной диверсификации остается относительно низким. Цель исследования заключается в оценке потенциального макроэкономического воздействия ИИ в различных секторах и определении условий его вклада в устойчивое экономическое развитие. Используется отраслевая аналитическая модель, объединяющая данные национальных счетов с коэффициентами производительности ИИ, полученными из международных эмпирических исследований. Анализ охватывает промышленность, торговлю, транспорт, энергетику, финансы, сельское хозяйство, здравоохранение и телекоммуникации. Особое внимание уделяется машинному обучению, глубокому обучению, большим языковым моделям и генеративному ИИ, которые создают дополнительные возможности для автоматизации и поддержки принятия решений. При принятых допущениях сценарная модельная оценка показывает, что потенциальный экономический эффект от внедрения ИИ в Казахстане может составлять 1,6–2,59 млрд долларов США в год, или около 0,9%–1,5% ВВП. Данную оценку следует интерпретировать как индикативный сценарный результат, основанный на международных коэффициентах производительности и отраслевой структуре ВВП Казахстана, а не как прямое эмпирическое измерение текущего уровня внедрения ИИ на казахстанских предприятиях. Наиболее существенный потенциальный эффект концентрируется в промышленности, торговле и транспорте, тогда как вклад других секторов

более умерен, но сохраняет макроэкономическую значимость. На современном этапе ИИ выступает прежде всего инструментом повышения эффективности, а не полноценным драйвером структурной трансформации. К основным ограничениям относятся недостаточная цифровая инфраструктура, дефицит человеческого капитала, низкая интенсивность исследований и разработок, а также зависимость экономики от ресурсоемких отраслей. Эти факторы ограничивают распространение технологий ИИ и их мультипликативный эффект. Результаты указывают на необходимость согласованной политики в области технологической модернизации, образования и экономической диверсификации. Без дополнительных мер по развитию цифровой инфраструктуры, человеческого капитала и диверсификации экономики внедрение ИИ может усиливать существующие структурные дисбалансы вместо ускорения перехода к экономике, основанной на знаниях.

Ключевые слова: искусственный интеллект; ресурсо-ориентированная экономика; экономический эффект; машинное обучение; большие языковые модели (LLM); генеративный ИИ; цифровая трансформация

Introduction. In resource-oriented economies, natural resources extraction and export has been the main economic driver for the past years. But this type of growth is facing increasing structural weaknesses as a result of commodity price volatility, external shocks and long-term pressures for decarbonization. Under those circumstances, new targets for productivity and diversification are a key policy focus. Kazakhstan is a representative case of this type of economy as mineral production and other mining industries account for most of its gross output, while the contribution of high-tech industries is relatively small (Bureau of National Statistics, 2026; World Bank, 2026; International Trade Centre, 2026; Harvard Growth Lab, 2026; WIPO, 2026).

Meanwhile, artificial intelligence (AI) has proven to be a general-purpose technology with the potential to revolutionize production systems, decision-making processes, and service delivery across industries. Modern machine learning and deep learning (DL) based AI systems are capable of processing unstructured data, learning from large-scale data sets, and providing cognitive functions at or exceeding human-level performance in narrow domains, unlike previous AI initiatives that were limited to narrow tasks using structured data (LeCun et al., 2015; Mukhamediev et al., 2022). This makes AI a possible game-changer for industrial efficiency and structural economic change.

Large language models (LLMs) and generative AI (GenAI) have revolutionized the applications of AI over the last few years. In addition to predictive analytics, these models can also be used for automated content creation, complex reasoning over text, and multimodal analysis, which is a shift from traditional types of AI usage into knowledge-intensive tasks (Raiaan et al., 2024; Naveed et al., 2023). Therefore, AI is becoming an emerging platform for innovation as well as optimization in finance, healthcare, education and public administration.

This potential is very much reliant on institutional preparedness, human resources, and the economic structure. Empirical evidence has indicated that AI is able to deliver significant productivity gains, though this varies by sector and country (Zhao, 2018; McKinsey and Company, 2023). While the integration of AI technologies into the existing economy is crucial for resource-based economies like Kazakhstan, the challenge lies not just in the adoption but also in the seamless incorporation of these technologies into a comprehensive diversification policy aimed at shifting away from extractive industries (OECD, 2023; Mannuru et al., 2023).

Hence, this study is aimed at evaluating the economic opportunities and structural barriers of AI usage in Kazakhstan. The sectoral distribution of potential gains is addressed in particular, as are the opportunities of new technologies like LLMs for future development paths. More specifically, the study provides a first-order scenario-based estimate of the potential macroeconomic effect of AI adoption in Kazakhstan under internationally derived productivity assumptions, rather than a direct measurement of the current level of AI adoption by Kazakhstani enterprises.

Literary review. AI is considered a general purpose technology that can have applications across sectors. Traditional AI is generally defined as systems that mimic human intelligence, like learning, reasoning and decision making. The most common architectures are modern AI systems with machine learning, especially deep learning architecture that supports automatic feature extraction and hierarchical representation learning from large datasets (LeCun et al., 2015; Mukhamediev et al., 2020). Transformer-based architecture has advanced at a rapid pace, resulting in the birth of large language models, which are big milestones in the field of natural language processing and generative AI. The models exhibit high performance across a variety of text generation, translation, coding, and analytical reasoning tasks, thereby presenting a wide range of opportunities for AI use in knowledge-intensive areas (Raiaan et al., 2024; Naveed et al., 2023).

Economically, AI is increasingly examined as a technology that enhances productivity and has an impact on labour markets and capital utilization. According to global evaluations, AI can enhance production and logistics efficiency, risk management, and innovation processes (Zhao, 2018). The strength of these effects, however, will vary depending on the institutional landscape and the sectoral makeup. According to large scale industry studies, sectors where data is abundant and processes are standardized, like manufacturing, supply chain management and product development, are ones where AI adoption is most advanced (McKinsey and Company, 2023). On the macro level, AI is projected to boost productivity, but with varying effects across countries (OECD, 2021).

In economies with fewer resources and developing economies, the economic impact of AI can be limited by the availability of digital infrastructure and technological readiness (Mannuru et al., 2023). Thus, AI is often used to improve efficiency of current systems and industries instead of transforming them. Recent studies reveal the increasing use of AI in specific industry contexts. AI plays a

role in finance, such as risk assessment, fraud detection, and algorithmic trading, which enhances decision-making and streamlines operations. In the healthcare sector, AI and LLM-based systems aid in diagnosis, clinical decision support and administrative automation, leading to cost savings and better service provision (Nazi and Peng, 2024).

Additionally, research shows that AI can be a powerful tool for lowering healthcare costs, with potential for enhanced outcomes, especially in the field of predictive analytics and personalized medicine. But achieving these benefits requires data quality, regulatory measures, and the ability to integrate with current health systems. While AI has its merits, it also comes with a number of structural and institutional limitations. One of the key concerns is the potential for widening technological and economic inequality between advanced and developing economies. Moreover, the focus of AI capabilities in fewer countries and companies can further exacerbate inequalities within the world.

Ethical and governance issues also pose a major challenge. This applies to algorithmic bias, transparent algorithms, and issues of accountability in automated decision-making systems (Machado et al., 2025). In addition, the economic advantages of AI could be counterbalanced by the disruption of the labor market, such as in repetitive and semi-automated roles. Last but not least, theoretical work indicates that AI can exacerbate the structural challenges of resource-poor economies if adequate investments in human resources and institutions are not made (Korinek and Stiglitz, 2021).

Materials and methods. In this study, the quantitative sectoral assessment approach is used to estimate the potential impact of artificial intelligence (AI) on the economy of Kazakhstan. Analysis is based on a mixed methodological approach, which consists of macroeconomic structure analysis, sectoral decomposition of GDP and AI impact coefficients drawn from literature. The goal is to estimate the economic impacts of both partial and full AI use in the major sectors of the economy.

The research design is comparative structural, which is based on the analysis of the sectors of Kazakhstan's economy and their status in comparison with the patterns of AI adoption and productivity gains reported in international studies (Zhao, 2018; McKinsey and Company, 2023). The sources of materials in the study are of secondary data which is obtained from national and international statistical database. The main macroeconomic indicators and sectoral GDP structure are taken from the Annual Report of the Bureau of National Statistics of the Republic of Kazakhstan and the World Bank (Bureau of National Statistics, 2026; World Bank, 2026). International trade and competitiveness data (International Trade Centre, 2026; Harvard Growth Lab, 2026) also provide further sectoral breakdowns of economic activity.

Further information is added on innovation capacity and technological readiness based on the Global Innovation Index (WIPO, 2026). These datasets are used as the structural building blocks to calculate sectoral exposure to AI-driven productivity

gains. The main sectors of Kazakhstan's economy are industry, trade, transport, agriculture, finance and real estate, health care, communications and energy. This classification is consistent with the national reporting standards for accounts and GDP structure.

Each sector is analyzed in terms of:

- Contribution to GDP (sectoral volume)
- Functional composition of business activities (manufacturing, risk management, supply chain, product development),
- Suitability for AI adoption based on digitalization intensity.

The conceptual model of the proposed sectoral approach to estimating the economic impact of artificial intelligence is shown in Figure 1. The model starts by dividing the national economy into its main sectors such as industry, trade, finance, agriculture and energy. In addition, each sector has a specific group of business functions—including manufacturing, risk management, supply chain operations, and product development—that are key areas where AI technologies impact productivity. There are impact coefficients (I_{min} and I_{max}) that indicate the level of transformation related to AI, based on the productivity gains found in empirical research. These factors are used on specific functional structures of each sector to calculate potential gains in efficiency. The model output is the impact on the economy of the sector, as a range of expected changes in revenue or GDP contribution (R_{min} and R_{max}). This approach allows for a process-oriented mapping of the impacts of the use of functional AI into macroeconomic results.

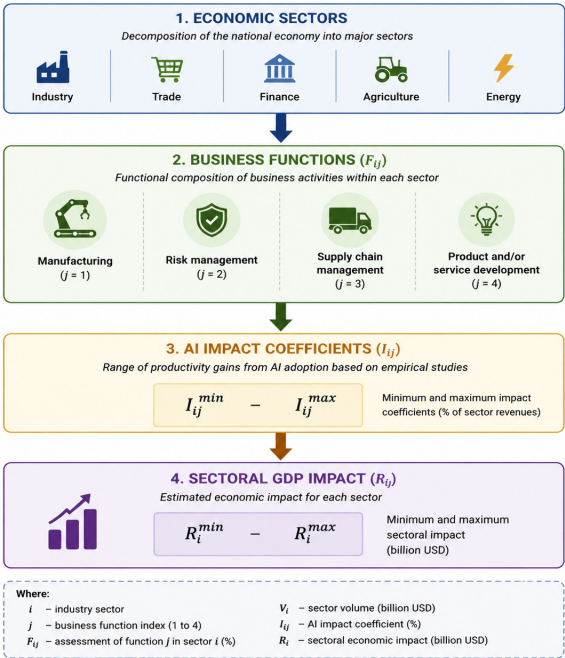


Figure 1 — Conceptual framework of sectoral AI impact estimation model.

To estimate the economic impact of AI, a functional model is applied based on sectoral revenue and AI-induced efficiency gains. The potential economic effect is calculated using the following formulation:

$$\begin{aligned} R_i^{\min}(V_i, F_i, I_i) &= V_i \cdot \max_j(F_{ij}) \cdot I_i^{\min}, \\ R_i^{\max}(V_i, F_i, I_i) &= V_i \cdot \max_j(F_{ij}) \cdot I_i^{\max} \end{aligned} \quad (1)$$

where

i — industry sector; j — business function index: 1 — manufacturing, 2 — risk, 3 — supply-chain management, 4 — product and/or service development; F_{ij} — assessment of business function j for industry i , as a percent of respondents; V_i — sector volume in billion USD; $I_i^{\min}, I_i^{\max}$ — minimal and maximal impact as % of industry revenues

The impact coefficients are based on empirical research on the productivity gains of AI in various industries, including industry-level assessments of AI adoption and enterprise-level surveys (Zhao, 2018; McKinsey and Company, 2023).

The coefficients F and I are not Kazakhstan-specific. They are derived from international enterprise surveys and are used in this study as proxy parameters in the absence of representative firm-level data for Kazakhstan. Consequently, the results should not be interpreted as direct empirical evidence of the current level of AI adoption in Kazakhstan. Rather, they represent an indicative estimate of potential gains under externally benchmarked productivity assumptions.

The maximum value across business functions is used to identify the dominant AI-relevant functional channel within each sector. This conservative procedure is adopted to avoid double counting, since AI applications in production, risk management, supply-chain management, and product or service development may overlap within the same enterprises and business processes. Therefore, the model does not assume that all functional effects are additive. The use of the maximum coefficient should be interpreted as a simplifying assumption for a first-order sectoral estimate rather than as a complete representation of all AI-related productivity channels.

The model is based on several key assumptions. First, it assumes that the use of AI technologies will be incremental rather than comprehensive across all industries, which is suitable for most developing and resource-based economies with pragmatic limitations in widespread adoption. Second, the sectoral composition of GDP is fixed during the estimation period – i.e., the effects of the structural change resulting from AI or other structural changes are ignored explicitly. Third, impact coefficient values calculated with the aid of AI on the basis of international empirical studies are assumed to be transferable to Kazakhstan, however, it is recognized that among economies there are structural differences that may cause deviation from the estimated impact coefficient. Fourth, sectoral effects are considered separately,

while possible inter-sectoral effects or feedback are not incorporated into the estimation framework. These assumptions are in line with the existing methods in the macroeconomic evaluation of AI implementation (OECD, 2023; Mannuru et al., 2023).

Alternative aggregation rules may produce different estimates. An additive approach would likely overestimate the impact because of overlapping AI applications across business functions. A weighted-average approach would be methodologically preferable, but it requires firm-level or sector-specific data on the relative importance of business functions in Kazakhstan, which are currently unavailable. For this reason, the maximum-based specification is retained as a transparent and conservative baseline.

The analytical procedure is carried out in four stages. First, macroeconomic data is collected and normalized, and attention is given to the structure of GDP and the role of the various sectors of the national economy. The second phase involves identifying the functions in the business that are relevant to AI and mapping them to the different sectors of the economy to pinpoint areas where businesses can benefit from AI and intelligent systems for improved productivity. In the third step, AI impact coefficients are applied to each sector to estimate potential productivity gains at both the minimum and maximum levels. The final stage involves consolidating results from the various sectors to calculate the overall potential economic impact of using AI at the national level. The estimates obtained are expressed in absolute monetary units (USD) and in relative terms (as percentage of GDP) for ease of comparison with international benchmarks and cross-country studies.

There are several limitations in the proposed methodology which should be taken into account when interpreting the results. It does not explicitly consider dynamic feedback effects in the system between the sectors and long-term structural shifts which could occur due to the widespread use of AI. Moreover, AI impact coefficients are derived from external sources and may create estimation bias since they are derived in different institutional and economic conditions. Moreover, micro level firm data are not included in the approach that could offer more detailed knowledge about the different effects on productivity at the firm level. The proposed assessment should therefore be interpreted as a potential rather than observed estimate of the economic effect of AI adoption in Kazakhstan. The reported range reflects variation in minimum and maximum impact coefficients, but it does not represent a full probabilistic uncertainty interval. The model also does not include implementation costs, differences in firms' technological readiness, or a sensitivity analysis with respect to all possible methodological assumptions. These limitations define the results as an indicative baseline for further empirical research rather than as a definitive measurement of AI adoption effects in Kazakhstan.

While it has its constraints, the approach can be considered a first-order approximation in an economy centered around resources like Kazakhstan, offering an analytical starting point for future empirical studies as well as policy-oriented research.

Results. The results of the sectoral assessment indicate that the economic impact of artificial intelligence (AI) in Kazakhstan is highly concentrated in a limited number of large-scale sectors. As shown in Figure 2, the national economy is strongly resource-oriented, with industry (including extractive activities), trade, and transport forming the dominant components of GDP. This structural configuration largely determines the distribution of potential AI-related gains.

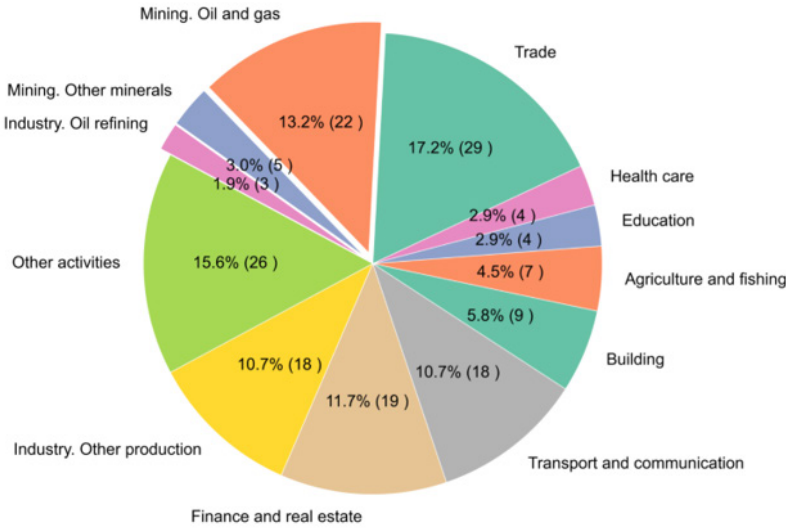


Figure 2 — Structure of Kazakhstan’s GDP.

The results of the estimation (Table 1) show that the economic impact of using AI is greatest in the industrial sector, where the potential increase in value ranges from USD 0.62 to 0.96 billion. The large percentage of manufacturing-oriented activities such as production optimization, predictive maintenance and supply chain automation, are the main factors behind this outcome. Trade is the second major contributor with estimated gains ranging from USD 0.35 to 0.63 billion, underscoring the potential of AI in logistics optimization, demand forecasting, and risk management. Given the functioning of the industries in Kazakhstan, the economic prospects of the use of AI in the Republic of Kazakhstan can be assessed (Table 1). In the table: F_1 — Manufacturing, F_2 — Risk, F_3 — Supply-chain management, F_4 — Product and/or service development.

Table 1 —Estimated economic effect of AI by sector.

Branch of the economy	V	F_1	F_2	F_3	F_4	I^{min}	I^{max}	R^{min}	R^{max}
Industry	48.77	49	2	11	39	2.6	4.0	0.62	0.96
Trade	29.18	7	9	38	13	3.2	5.7	0.35	0.63
Transport	14.49	4	4	18	34	4.9	6.4	0.24	0.32

Branch of the economy	V	F_1	F_2	F_3	F_4	I^{min}	I^{max}	R^{min}	R^{max}
Agriculture and fishing	7.66	*30	-	-	-	2.4	3.7	0.06	0.09
Finance and real estate	19.93	6	40	7	26	2.5	5.2	0.20	0.41
Health care	4.85	9	19	21	28	2.9	3.7	0.04	0.05
Communication	3.62	22	23	26	45	2.9	6.3	0.05	0.10
Power supply	3.23	19	14	14	41	1.8	1.9	0.02	0.03
Note: compiled by the authors based on (Bureau of National Statistics, 2026; McKinsey and Company, 2023). *Approximate value.									

Under the adopted assumptions, the indicative potential gains from AI technologies in Kazakhstan are estimated at USD 1.6–2.59 billion, or 0.9–1.5% of GDP. This range should be understood as a model-based scenario estimate rather than as a direct measurement of realized economic gains. The transport sector shows high potential and pledges estimated benefits ranging from USD 0.24 to 0.32 billion. This is connected to route optimization, fleet management and predictive analysis on infrastructure usage. The three sectors make up the bulk of the national estimated AI-driven economic impact.

Other industries, such as finance, agriculture, communications, health care, and energy, show comparatively smaller, but significant contributions. In the cases of agriculture and healthcare, the absolute increases in efficiency are comparatively small, because the size of the sector is comparatively small and the level of digitalization is comparatively low. Finance, by contrast, demonstrates relatively strong efficiency gains. The aggregated results indicate that the total potential economic impact of the use of AI in Kazakhstan can be from USD 1.6 billion to USD 2.59 billion per year, or about 0.9% – 1.5% of the national income. The estimate is significant because it indicates that the use of AI, even to a limited extent, can have meaningful macroeconomic impacts, especially in industries with significant industrial and logistics components.

The benefits of these gains, however, remain unevenly distributed, and there is clearly a focus on sectors already structurally dominant in the economy. The result shows that the current use of AI is more of an efficiency tool, rather than a driver of structural change. The findings observed were consistent with the results in international studies, which also predicted a very economy-specific effect of AI (Zhao, 2018; McKinsey and Company, 2023). For Kazakhstan, the reliance on resource extraction and logistics demands heightens the operational optimization impact of AI, while also curbing its potential for transformation.

Discussion. The GDP structure is still dominated by resource-based industries, leading to the highest gains in AI in the industry, trade and transport sector, as shown in Figure 2. This supports the hypothesis that adoption of AI in resource-oriented economies will reinforce existing patterns of structure rather than disrupt them. Meanwhile, the relatively smaller (but not insignificant) impact of finance, health care and communications suggest that pathways of diversification are beginning to operate. These industries are more closely tied to data-intensive and

knowledge-based activities, and are more likely to be sensitive to generative AI and large language models in the long run.

Large Language Models (LLMs) and Generative AI add a new layer of economic analysis. GenAI systems are different from conventional machine learning systems, which are traditionally used for prediction and classification, and can be used to create content, make decisions, and automate cognitive tasks in various areas. These technologies can broaden the scope of the use of AI in Kazakhstan's sectors such as finance, public administration, healthcare, and education. However, their economic role is still limited due to the infrastructure constraints and lack of specialized human capital and data. This is consistent with the global research that shows a wide disparity in the rate of uptake of advanced AI tools by countries and industry sectors (Raiaan et al., 2024; Mannuru et al., 2023).

The results found are in line with findings from other high-resource countries utilizing AI to enhance extraction, distribution and operational efficiency, but not for structural transformation. In fact, as seen from the experience of countries around the world including Norway, Saudi Arabia and Chile, increased gains from the adoption of AI technologies can be realized in the long term, when accompanied by institutional development and diversification strategies.

On the other hand, countries with a major dependence on resource extraction, without the presence of any high technology industry, experience low multipliers. This further confirms that there is a need for complementary reforms in education, innovation policy and institutional capabilities to transform the economic fabric alongside the role of AI.

The findings indicate that the use of AI in Kazakhstan should not be limited to individual sectors, as it also needs to transform the system. The maximum economic benefits will likely be realized through the combination of industrial diversification, human capital investment and building digital infrastructure in support of AI adoption.

It is crucial to pay special attention to creating conditions for scaling AI beyond extractive industries, such as developing national data ecosystems and supporting innovation-driven industries. If these steps aren't taken, AI will continue to be viewed as a means to incremental efficiency gains and won't usher in a permanent economic restructuring.

In general, the outcomes show that the economic value of AI is promising but not uniform in Kazakhstan. Results indicate a macroeconomic relevance of up to 1.5% of GDP, but with a high focus of benefits in the few sectors, it shows limitations in the economic structure based on resources. The results also indicate a need for synergic technological, institutional, and educational changes in order to move from an efficiency to an AI-driven transformation.

Conclusion. The study focused on the economic opportunities and structural factors affecting the implementation of artificial intelligence (AI) in the context of the economy of Kazakhstan, which is dominated by the extractive sector and is relatively undeveloped in terms of its high-tech component. The research employs

a sectoral decomposition methodology and estimates of AI productivity gains at the international level to give a ballpark figure of the potential macroeconomic effects of AI in major sectors of the economy. Under the adopted assumptions, the model-based scenario estimate suggests that the potential economic impact of AI adoption could reach USD 1.6–2.59 billion, or roughly 0.9%–1.5% of GDP per year. This estimate should be interpreted as an indicative potential effect based on international productivity coefficients and Kazakhstan's current sectoral structure, not as an empirical measurement of the current level of AI implementation in Kazakhstani enterprises. The biggest absolute improvements are found in industry, trade and transport, driven by the criticality of the field and the significant role of AI for optimisation. These other sectors include finance, communications, healthcare, agriculture and energy, and show potential benefits albeit on a smaller scale, in areas including data processing, risk management, and decision support. The study also revealed that the potential impact of AI on the country's economy is structurally limited by the national economy. Current use of AI is mostly about optimizing processes within existing industries and sectors, and is not yet transformative. If AI isn't diversified, it could further reinforce the current economic trends and not usher in a knowledge economy. The study also reveals that new technologies like Generative AI and large language models bring more possibilities for the use of automation than with conventional technology. While these technologies have special significance for the finance sector, public administration, healthcare and education, their successful implementation requires access to digital infrastructure, qualified human resources and good national data ecosystems. The study indicates that the economic prospects of AI in Kazakhstan will depend on the extent and speed of its adoption and the scale of institutional reforms and strategic diversification measures. To turn AI from an efficiency tool to a catalyst for sustainable economic development, it is crucial to build up the capacity of RandD, invest in digital skills, and promote innovation ecosystems between sectors. Additional studies will require more detailed micro-level information, dynamic modelling of inter-sectoral effects and analysis of the cumulative impacts of generative AI technologies, which are likely to have a growing influence in driving economic outcomes in resource-rich nations.

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