

ISSN: 1991-3494 (Print)
ISSN: 2518-1467 (Online)

**SCIENTIFIC JOURNAL OF
PEDAGOGY AND ECONOMICS**

**№2
2026**

ISSN 2518-1467 (Online),
ISSN 1991-3494 (Print)



CENTRAL ASIAN ACADEMIC
RESEARCH CENTER



SCIENTIFIC JOURNAL OF PEDAGOGY AND ECONOMICS

PUBLISHED SINCE 1944

2 (420)

March – April 2026

ALMATY, 2026

EDITOR-IN-CHIEF:

ABYLKASSIMOVA Alma Yesimbekovna, Doctor of Pedagogical Sciences, Professor, Academician of Central Asian Academic Research Center, Director of the Center for the Development of Pedagogical Education, Head of the Department of Methods of Teaching Mathematics, Physics and Computer Science at Abai KazNPU (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=57191275199>, <https://www.webofscience.com/wos/author/record/2076124>.

DEPUTY EDITOR-IN-CHIEF:

SEMBIEVA Lyazzat Myktybekovna, Doctor of Economics, Professor of the Eurasian National University (Astana, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=57194226348>, <https://www.webofscience.com/wos/author/record/38875302>.

EDITORIAL BOARD:

RICHELLE Marynowski, PhD in Education, Professor, Faculty of Education, University of Lethbridge, (Alberta, Canada), <https://www.scopus.com/authid/detail.uri?authorId=57070452800>, <https://www.webofscience.com/wos/author/record/16130920>.

SHISHOV Sergey Evgenievich, Doctor of Pedagogical Sciences, Professor, Head of the Department of Pedagogy and Psychology of Professional Education, Moscow State University of Technology and Management named after K. Razumovsky (Moscow, Russia), <https://www.scopus.com/authid/detail.uri?authorId=57191518233>, <https://www.webofscience.com/wos/author/record/2443966>.

ABILDINA Saltanat Kuatovna, Doctor of Pedagogical Sciences, Professor, Head of the Department of Pedagogy, Karaganda University named after E.A. Buketov (Karaganda, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=56128026400>, <https://www.webofscience.com/wos/author/record/4131549>.

RYZHAKOV Mikhail Viktorovich, Doctor of Pedagogical Sciences, Professor, Academician of the Russian Academy of Education, Editor-in-Chief of the journal "Standards and Monitoring in Education" (Moscow, Russia), <https://www.scopus.com/authid/detail.uri?authorId=6602245542>, <https://www.webofscience.com/wos/author/record/13675462>.

BULATBAEVA Kulzhanat Nurymzhanovna, Doctor of Pedagogical Sciences, Professor, Chief Researcher of the National Academy of Education named after Y. Altynsarin (Astana, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=57202195074>, <https://www.webofscience.com/wos/author/record/40173122>.

PETR Hájek, PhD, Unicorn University, Associate Professor, Department of Finance, (Prague, Czech Republic), <https://www.scopus.com/authid/detail.uri?authorId=35726855800>, <https://www.webofscience.com/wos/author/record/672404>.

JUMAN Jappar, Doctor of Economics, Professor, Honorary Academician of Central Asian Academic Research Center, Honored Worker of Kazakhstan, Director of the Center for International Applied Research Al-Farabi Kazakh National University (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=59238481900>; <https://www.scopus.com/authid/detail.uri?authorId=56658765400>, <https://www.webofscience.com/wos/author/record/60977874>.

LUKYANENKO Irina Grigorievna, Doctor of Economics, Professor, Head of Department of the National University of Kyiv-Mohyla Academy (Kyiv, Ukraine), <https://www.scopus.com/authid/detail.uri?authorId=57189348551>, <https://www.webofscience.com/wos/author/record/939510>.

YESIMZHANOVA Saira Rafihevna, Doctor of Economics, Professor of the University of International Business (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=56499485500>, <https://www.webofscience.com/wos/author/record/45951098>.

Scientific Journal of Pedagogy and Economics

ISSN 2518-1467 (Online),

ISSN 1991-3494 (Print).

Owner: «Central Asian Academic Research Center» LLP (Almaty).

The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Communications of the Republic of Kazakhstan

№ KZ50VPY00121155, issued on 05.06.2025

Thematic focus: «*publication of the results of new achievements in the field of fundamental sciences*»

Periodicity: 6 times a year.

<http://www.bulletin-science.kz/index.php/en/>

© «Central Asian Academic Research CenterB» LLP, 2026



БАС РЕДАКТОР:

ӘБІЛҚАСЫМОВА Алма Есімбекқызы, педагогика ғылымдарының докторы, профессор, ҚР ҰҒА академигі, Педагогикалық білім беруді дамыту орталығының директоры, Абай атындағы ҚазҰПУ математика, физика және информатиканы оқыту әдістемесі кафедрасының меңгерушісі (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=57191275199>, <https://www.webofscience.com/wos/author/record/2076124>.

БАС РЕДАКТОРДЫҢ ОРЫНБАСАРЫ:

СЕМБИЕВА Ләззат Мықтыбекқызы, экономика ғылымдарының докторы, Л.Н. Гумилев атындағы Еуразия ұлттық университетінің профессоры (Астана, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=57194226348>, <https://www.webofscience.com/wos/author/record/38875302>.

РЕДАКЦИЯ АЛҚАСЫ:

РИШЕЛЬ Мариновски, білім беру саласындағы PhD, Летбридж университеті педагогика факультетінің профессоры, (Альберта, Канада), <https://www.scopus.com/authid/detail.uri?authorId=57070452800>, <https://www.webofscience.com/wos/author/record/16130920>.

ШИШОВ Сергей Евгеньевич, педагогика ғылымдарының докторы, профессор, К. Разумовский атындағы Мәскеу мемлекеттік технологиялар және басқару университетінің кәсіби білім беру педагогикасы және психологиясы кафедрасының меңгерушісі (Мәскеу, Ресей), <https://www.scopus.com/authid/detail.uri?authorId=57191518233>, <https://www.webofscience.com/wos/author/record/2443966>.

ӘБІЛДИНА Салтанат Қуатқызы, педагогика ғылымдарының докторы, профессор, Е.А. Бөкетов атындағы Қарағанды университетінің педагогика кафедрасының меңгерушісі (Қарағанды, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=56128026400>, <https://www.webofscience.com/wos/author/record/4131549>.

РЫЖАКОВ Михаил Викторович, педагогика ғылымдарының докторы, профессор, Ресей білім академиясының академигі, «Білім берудегі стандарттар мен мониторинг» журналының бас редакторы (Мәскеу, Ресей), <https://www.scopus.com/authid/detail.uri?authorId=6602245542>, <https://www.webofscience.com/wos/author/record/13675462>.

БОЛАТБАЕВА Күлжанат Нұрымжанқызы, педагогика ғылымдарының докторы, профессор, Ы.Алтынсарин атындағы Ұлттық білім академиясының бас ғылыми қызметкері (Астана, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=57202195074>, <https://www.webofscience.com/wos/author/record/40173122>.

ПЕТР Хайек, PhD, Юникорн университеті, Қаржы департаментінің қауымдастырылған профессоры (Прага, Чехия), <https://www.scopus.com/authid/detail.uri?authorId=35726855800>, <https://www.webofscience.com/wos/author/record/672404>.

ЖҰМАН Жаппар, экономика ғылымдарының докторы, профессор, Қазақстанның Еңбек сіңірген қайраткері, ҚР ҰҒА құрметті академигі, әл-Фараби атындағы Қазақ ұлттық университетінің Халықаралық қолданбалы зерттеулер орталығының директоры (Алматы, Қазақстан). <https://www.scopus.com/authid/detail.uri?authorId=59238481900>; <https://www.scopus.com/authid/detail.uri?authorId=56658765400>, <https://www.webofscience.com/wos/author/record/60977874>.

ЛУКЪЯНЕНКО Ирина Григорьевна, экономика ғылымдарының докторы, профессор, «Киево-Могилянская академия» ұлттық университеті кафедрасының меңгерушісі (Киев, Украина), <https://www.scopus.com/authid/detail.uri?authorId=57189348551>, <https://www.webofscience.com/wos/author/record/939510>.

ЕСІМЖАНОВА Сайра Рафиққызы, экономика ғылымдарының докторы, Халықаралық бизнес университетінің профессоры (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=56499485500>, <https://www.webofscience.com/wos/author/record/45951098>.

Scientific Journal of Pedagogy and Economics

ISSN 2518-1467 (Online),

ISSN 1991-3494 (Print).

Меншіктенуші: «Орталық Азия академиялық ғылыми орталығы» ЖШС (Алматы қ.).

Қазақстан Республикасының Ақпарат және коммуникациялар министрлігінің Ақпарат комитетінде 05.06.2025 ж. берілген № **KZ50VPY00121155** мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Тақырыптық бағыты: *«іргелі ғылым салалары бойынша жаңа жетістіктердің нәтижелерін жариялау»*

Мерзімділігі: жылына 6 рет.

<http://www.bulletin-science.kz/index.php/en/>

© «Орталық Азия академиялық ғылыми орталығы» ЖШС, 2026

ГЛАВНЫЙ РЕДАКТОР:

АБЫЛКАСЫМОВА Алма Есимбековна, доктор педагогических наук, профессор, академик НАН РК, директор Центра развития педагогического образования, заведующая кафедрой методики преподавания математики, физики и информатики КазНПУ им. Абая (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=57191275199>, <https://www.webofscience.com/wos/author/record/2076124>.

ЗАМЕСТИТЕЛЬ ГЛАВНОГО РЕДАКТОРА:

СЕМБИЕВА Лязат Мыктыбековна, доктор экономических наук, профессор Евразийского национального университета им. Л.Н. Гумилева (Астана, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=57194226348>, <https://www.webofscience.com/wos/author/record/38875302>.

РЕДАКЦИОННАЯ КОЛЛЕГИЯ:

РИШЕЛЬ Мариновски, PhD в области образования, профессор факультета педагогики Летбриджского университета, (Альберта, Канада), <https://www.scopus.com/authid/detail.uri?authorId=57070452800>, <https://www.webofscience.com/wos/author/record/16130920>.

ШИШОВ Сергей Евгеньевич, доктор педагогических наук, профессор, заведующий кафедрой педагогики и психологии профессионального образования Московского государственного университета технологий и управления имени К. Разумовского (Москва, Россия), <https://www.scopus.com/authid/detail.uri?authorId=57191518233>, <https://www.webofscience.com/wos/author/record/2443966>.

АБИЛЬДИНА Салтанат Куатовна, доктор педагогических наук, профессор, заведующая кафедрой педагогики Карагандинского университета имени Е.А. Букетова (Караганда, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=56128026400>, <https://www.webofscience.com/wos/author/record/4131549>.

РЫЖАКОВ Михаил Викторович, доктор педагогических наук, профессор, академик Российской академии образования, главный редактор журнала «Стандарты и мониторинг в образовании» (Москва, Россия), <https://www.scopus.com/authid/detail.uri?authorId=6602245542>, <https://www.webofscience.com/wos/author/record/13675462>.

БУЛАТБАЕВА Кулжанат Нурымжановна, доктор педагогических наук, профессор, главный научный сотрудник Национальной академии образования имени Ы. Алтынсарина (Астана, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=57202195074>, <https://www.webofscience.com/wos/author/record/40173122>.

ПЕТР Хайек, PhD, университет Юникорн, ассоциированный профессор Департамента финансов, (Прага, Чехия), <https://www.scopus.com/authid/detail.uri?authorId=35726855800>, <https://www.webofscience.com/wos/author/record/672404>.

ЖУМАН Жаппар, доктор экономических наук, профессор, заслуженный деятель Казахстана, почетный академик НАН РК, директор Центра Международных прикладных исследований Казахского национального университета им. аль-Фараби (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=59238481900>; <https://www.scopus.com/authid/detail.uri?authorId=56658765400>, <https://www.webofscience.com/wos/author/record/60977874>.

ЛУКЪЯНЕНКО Ирина Григорьевна, доктор экономических наук, профессор, заведующая кафедрой Национального университета «Киево-Могилянская академия» (Киев, Украина), <https://www.scopus.com/authid/detail.uri?authorId=57189348551>, <https://www.webofscience.com/wos/author/record/939510>.

ЕСИМЖАНОВА Сайра Рафихевна, доктор экономических наук, профессор Университета международного бизнеса (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=56499485500>, <https://www.webofscience.com/wos/author/record/45951098>.

Scientific Journal of Pedagogy and Economics

ISSN 2518-1467 (Online),

ISSN 1991-3494 (Print).

Собственник: ТОО «Центрально-азиатский академический научный центр» (г. Алматы).

Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и коммуникаций и Республики Казахстан

№ KZ50VPY00121155 выданное 05.06.2025 г.

Тематическая направленность: «публикация результатов новых достижений области фундаментальных наук».

Периодичность: 6 раз в год.

<http://www.bulletin-science.kz/index.php/en/>

© ТОО «Центрально-азиатский академический научный центр», 2026



CONTENTS

PEDAGOGY

Aitimbaev A., Issayev M., Apendiyev T. Scientific and methodological opportunities for using archival materials in teaching the history of Kazakhstan in higher education institutions.....	19
Akhmetova G., Kabdusheva A., Mussina A. A quantitative study on university students' academic writing challenges and learning needs.....	40
Akhmetova Zh.A., Nurgali S., Nurmetova D. Pedagogical foundations of using digital resources in teaching academic writing.....	57
Bekbolat Zh., Zholmakhanova A., Yildirim S. Theoretical foundations of teaching M. Shokai's letters through a research-based approach.....	72
Berdenkulova A.Zh., Zhandavletova R.B., Nazarova G.A. A pedagogical model for improving educational quality through the "comfortable school - society - university" partnership.....	88
Duisenova G., Shyndaliyev N., Shadiyev R. Comparative analysis of traditional and virtualized programming education.....	104
Yeskendirova A., Kassenova N., Nogoyev Y. Comparative analysis of texts created by AI and texts developed using quantization technology.....	121
Zhanysbekova Sh., Nurmakhanova Zh., Akasheva A. Actual problems of the formation of pragmatic competence: research based on the results of content analysis.....	136
Zulpykhar Zh.E., Kapanova D.E., Zhilmagambetova R.Z. Modern resources and technologies as a foundation for the development of teachers' professional competencies.....	153
Isaeva A., Ananyeva S. Axiological interpretation of the Kazakhstan theme in the works of K. Paustovsky: methodological approaches to teaching at the university.....	172
Kabzhalelov K.R., Korganbayeva Zh.K., Nurakhmetova A.R. Developing critical thinking through modern chatbots in chemistry education.....	190
Kazhenova Zh.S., Kydyralina L.M., Rakhmatullina Z.T. Problems of developing students' engineering skills.....	208

Kaldarova A., Vasquez M., Kulgildinova T. Developing students' profession-oriented speaking skills through ChatGPT.....	229
Kapbarova G.Sh., Gundogdu A., Baidalieva E.A. History teaching methodology: theoretical and practical foundations of the competency-based approach.....	243
Kozhakhanova L., Amirova A. Prospects for developing media literacy among primary school students.....	260
Kuzhagulova G., Sydykova R., Smailova M Features of education of national values in visually impaired students through Kazakh lyric songs.....	278
Markhmadova Zh.K., Kassymova G.K., Okenova B. Pedagogical aspects of developing and assessing the digital competence of pedagogy-psychologists.....	297
Mateyeva M., Yeralin K., Burkitbaev T. Training future teachers of artistic work for art-historical regional studies.....	318
Makhanov N., Nishanova K. Development of students' cognitive competencies through museum-based education: evidence from South Kazakhstan.....	333
Myrzagereikyzy G., Yermekova Zh.K., Aldzhambekova G.T. The use of action research in preparing future physics teachers for the development of functional literacy of students.....	348
Reginbayeva N., Nametkulova F. Methodological foundations of professionally-oriented physics education based on STEM education for future air transport specialists.....	365
Serikbayeva N., Orynbekova A., Tuyakova U. Methodology for developing digital competence of educational psychologists in modern education.....	385
Toiganbekova M.E., Kazhigalieva G.A. Aspects of creation and specification of educational texts for increasing the effectiveness of training.....	409
Shegebayeva G., Zhumasheva T., Nurbekova S. Prerequisites for the preparation of future educators for the creation of a health-educational environment based on nutriscology.....	422
Shishov S.E., Iovbak A.S., Verko Y.A. Integrated modular physics experiment as a means of organizing students' experimental activities in secondary school.....	443

ECONOMICS

Abdimoldayeva A., Madysheva A., Zhunussova G. Transformation of logistics cost accounting in the agro-industrial complex under digitalization.....	461
Abuova Zh., Duiskenova R., Kadyrbekova D. The concept of sustainable development of the hotel business based on digital transformation and environmental management.....	479
Amantay Mukhit, Kanabekova M., Oralbayeva Zh. Digitalization as a driver of Kazakhstan's economic growth: econometric analysis and structural effects.....	494
Ashim N., Dzhrayova K., Kushenova M. Improving the management of agricultural subsidies: Kyzylorda region.....	511
Assemova R., Abdibekov S., Aitbayeva D. Energy efficiency and innovation in agriculture: empirical evidence from Southern Kazakhstan.....	535
Assanova Zh., Baimukhanova S., Konysbaeva G. Environmental accounting, ESG reporting and digitalization: impact on cost reduction and sustainable development.....	554
Baigelova A., Sadykova Zh., Epanchintseva S. Industrial economy transformation in Kazakhstan: structural shifts, digitalization and productivity growth.....	571
Beisekova Zh., Mutaliyeva A., Kunshigarova L. Transformation of entrepreneurial activity in Kazakhstan in 2000–2025.....	590
Beisenbayeva A., Kambarov B., Samenova N. Development of small and medium-sized enterprises in Almaty: ecosystem factors and structural dynamics.....	611
Bekisheva A., Beketova K., Dorohova N. Human resource management practices and employee perceptions in Kazakhstan's civil service.....	629
Bissenbayeva S., Kireyeva A., Zhumaxanova K. Digitalization, government support and innovation activity: evidence from regional analysis in Kazakhstan.....	646
Em O.L., Kim D. Features of risk management in collective investment.....	665

Ibrayeva A., Kenesheva G., Arynova Zh. Qualification mismatch in the labour market of an industrial region: a conceptual model and measurement mechanism.....	684
Juman J., Mukhtarova K.S., Liao Z. The modern model of China's economic cooperation with Central Asian countries.....	701
Karakulova A., Bakirbekova A., Zhangirova R. Improving the efficiency of digital transformation of agricultural enterprises: an empirical analysis of Kostanay region.....	718
Kuralbayeva A.Sh., Issayeva G.K., Zhussipova E.E. Energy-saving technologies in irrigated agriculture of Southern Kazakhstan: economic and environmental effects.....	734
Naimanova Zh., Bakirbekova A., Kuralbayeva R. Digital inequality and agricultural productivity: evidence from Southern Kazakhstan....	749
Nartbayeva A., Dadabayeva D., Altuntas G. Economic resilience of single-industry towns in Kazakhstan: a dynamic analysis of socio-economic indicators.....	767
Nurlanuly A., Petrovčíková K., Shalbolova U.Zh. Comparative analysis of aviation market development models in Kazakhstan and Slovakia.....	785
Nyshanbayeva U., Moldashbayeva L., Urazbayeva Z. Accounting and valuation of investment projects in digital tourism: an integrated approach.....	801
Shegir G., Kerimova U., Kabi Sh. The transition of the agro-industrial complex of the Almaty region to the production of value-added products.....	819
Shiganbayeva N., Razakova D., Orlowska R. Trade turnover between China and Kazakhstan in the context of contemporary analytical studies: factors, challenges, and risks.....	840
Tuzubekova M., Zhunusova A., Kadirova N. Analysis of SME support incentives in the manufacturing industry of the Republic of Kazakhstan.....	857
Yeraliyeva Ya., Ruziyeva E., Alimbekova B. Trend and structure of research on digital financial literacy: bibliometric approach.....	877
Zhassan G., Taibek Zh., Imanova G. Climate risk management in the banking sector: ESG-based global and Kazakhstani experience.....	891

МАЗМҰНЫ

ПЕДАГОГИКА

Айтимбаев А.Т., Исаев М.С., Апендиев Т.А. Қазақстан тарихын жоғары оқу орындарында оқытуда архив материалдарын пайдаланудың ғылыми-әдістемелік мүмкіндіктері (1920–1950 жж. Оңтүстік Қазақстандағы саяси қуғын-сүргін құрбандары тағдырлары негізінде).....	19
Ахметова Г.С., Кабдушева А.Б., Мусина А.Б. Университет студенттерінің академиялық жазылымдағы қиындықтары мен оқу қажеттіліктеріне арналған сандық зерттеу.....	40
Ахметова Ж.А., Нұрғали С., Нурметова Д. Академиялық жазуды оқытуда сандық ресурстарды пайдаланудың педагогикалық негіздері.....	57
Бекболат Ж.Н., Жолмаханова А.Б., Сейфуллах Йылдырым Мұстафа Шоқай хаттарын зерттеушілік әдіс арқылы оқытудың теориялық негіздері.....	72
Берденкулова А.Ж., Жандавлетова Р.Б., Назарова Г.А. «Жайлы мектеп – қоғам – университет» серіктестігі негізінде білім сапасын арттырудың педагогикалық моделі.....	88
Ескендірова А.А., Касенова Н.Б., Ногоев Ю.Я. ЖИ арқылы жасалған мәтіндер мен кванттау технологиясы арқылы әзірленген мәтіндердің салыстырмалы талдауы.....	104
Жанысбекова Ш., Нурмаханова Ж., Акашева Ә. Прагматикалық құзіреттілікті қалыптастырудың өзекті мәселелері: контент-анализ нәтижелері бойынша зерттеу.....	121
Дүйсенова Г.А., Шындалиев Н.Т., Шадиев Р.Н. Дәстүрлі және виртуалды бағдарламалау білімінің салыстырмалы талдауы.....	136
Зулпыхар Ж.Е., Капанова Д.Е., Жилмагамбетова Р.З. Педагогтердің кәсіби құзыреттілігін дамытудың негізі ретінде қазіргі заманғы ресурстар мен технологиялар.....	153
Исаева А.А., Ананьева С.В. К. Паустовский шығармашылығындағы Қазақстан тақырыбының аксиологиялық интерпретациясы: жоғары оқу орнында оқытудың әдіснамалық тәсілдері.....	172
Кабжалелов К.Р., Қорғанбаева Ж.Қ., Нурахметова А.Р. Химияны оқыту барысында заманауи чат-боттар арқылы сыни ойлауды дамыту.....	190

Каженова Ж.С., Қыдыралина Л.М., Рахматулина З.Т. Оқушылардың инженерлік дағдыларын дамыту мәселелері.....	208
Калдарова А.К., Васкес М.А., Кульгильдинова Т.А. Студенттердің кәсіби-бағдарланған айтылым дағдыларын ChatGPT арқылы дамыту.....	229
Капбарова Г.Ш., Гюндоду А., Байдалиева Э.А. Тарихты оқыту әдістемесі: құзыреттілікке негізделген тәсілді қолданудың теориялық және практикалық негіздері.....	243
Кожуханова Л., Амирова А. Бастауыш сынып оқушыларының медиасауаттылығын дамыту перспективалары.....	260
Кужагулова Г.Е., Сыдыкова Р.Ш., Смаилова М.С. Көру қабілеті бұзылған білім алушыларды қазақтың лирикалық әндері арқылы ұлттық құндылықтарға тәрбиелеудің ерекшеліктері.....	278
Мархмадова Ж.Қ., Касымова Г.К., Өкенова Б. Педагог-психологтың цифрлық құзыреттілігін қалыптастыру және бағалаудың педагогикалық аспектілері.....	297
Матеева М.А., Ералин Қ., Буркитбаев Т. Болашақ көркем еңбек мұғалімдерін өнертанымдық өлкетануға даярлау.....	318
Маханов Н., Нишанова К. Музейлік білім беру негізінде оқушылардың танымдық құзыреттіліктерін дамыту (Оңтүстік Қазақстан мысалында).....	333
Мырзагерейқызы Г., Еркекова Ж.К., Алджамбекова Г.Т. Болашақ физика мұғалімдерін оқушылардың функционалдық сауаттылығын дамытуға даярлауда action research пайдалану.....	348
Регинбаева Н.А., Наметкулова Ф.Д. Болашақ әуе транспорты мамандарына физиканы STEM білім беру негізінде кәсіби-бағдарлы оқытудың әдістемелік негіздері.....	365
Серикбаева Н.Б., Орынбекова А.С., Туякова У.Ж. Қазіргі білім беруде педагог-психологтардың цифрлық құзыреттілігін дамыту әдістемесі.....	385
Тойғанбекова М.Е., Қажығалиева Г.А. Оқытудың тиімділігін арттыру үшін оқу мәтіндерін құру және нақтылау аспектілері.....	409

Шегебаева Г.У., Жумашева Т.С., Нурбекова С.М.
Болашақ тәрбиешілерді нутрициология негізінде денсаулық сақтау-білім беру ортасын құруға дайындаудың алғышарттары.....422

Шишов С.Е., Иовбак А.С., Верко Е.А.
Орта мектепте оқушылардың эксперименталдық қызметін ұйымдастыру құралы ретінде интеграцияланған модульді физика эксперименті.....443

ЭКОНОМИКА

Абдимолдаева А., Мадышева А., Жунусова Г.
Цифрландыру жағдайында агроөнеркәсіптік кешендегі логистикалық шығындар есебін қайта құру.....461

Абуова Ж., Дүйсеннова Р., Кадырбекова Д.
Цифрлық трансформация және экологиялық басқару негізіндегі қонақ үй бизнесінің тұрақты даму тұжырымдамасы.....479

Әшім Н., Джрауова К., Кушенова М.
Ауылшаруашылығы субсидияларын басқаруды жетілдіру: Қызылорда облысы...494.

Мұхит Амантай, Кенабекова М., Оралбаева Ж.
Цифрландыру Қазақстанның экономикалық өсуінің драйвері ретінде: эконометрикалық талдау және құрылымдық әсерлер.....511

Асемова Р., Абдибеков С., Айтбаева Д.
Ауылшаруашылығындағы энергия тиімділігі және инновациялар: Оңтүстік Қазақстан бойынша эмпирикалық дәлелдер.....535

Асанова Ж., Баймуханова С., Қонысбаева Г.
Экологиялық есеп, ESG-есептілік және цифрландыру: шығындарды төмендетуге және орнықты дамуға әсері.....554

Байгелова А., Садыкова Ж., Епанчинцева С.
Қазақстандағы өнеркәсіп экономикасының трансформациясы: құрылымдық өзгерістер, цифрландыру және өнімділіктің өсуі.....571

Бейсекова Ж., Муталиева А., Куншигарова Л.
2000–2025 жылдары Қазақстандағы кәсіпкерлік қызметтің трансформациясы.....590

Бейсенбаева А., Қамбаров Б., Саменова Н.
Алматыда шағын және орта кәсіпкерлікті дамыту: экожүйелік факторлар және құрылымдық динамика.....611

Бекишева А., Бекетова К., Дорохова Н.
Қазақстанның мемлекеттік қызметіндегі адам ресурстарын басқару тәжірибелері және қызметкерлердің қабылдауы.....629

Бисенбаева С., Киреева А., Жұмаксанова К.

Цифрландыру, мемлекеттік қолдау және инновациялық белсенділік:
Қазақстан өңірлерінің талдауы.....646

Эм О.Л., Ким Д.

Ұжымдық инвестициялардағы тәуекелдерді басқарудың ерекшеліктері.....665

Ибраева А., Кенешева Г., Арынова Ж.

Өнеркәсіптік өңірдің еңбек нарығындағы біліктілік сәйкессіздігі:
тұжырымдамалық модель және өлшеу тетігі.....684

Жұман Ж., Мұхтарова К.С., Ляо Чжан

Қытайдың Орталық Азия елдерімен экономикалық ынтымақтастығының
заманауи моделі.....701

Қаракұлова А., Бакирбекова А., Жангирова Р.

Ауыл шаруашылығы кәсіпорындарының цифрлық трансформациясының
тиімділігін арттыру: Қостанай облысының эмпирикалық талдауы.....718

Құралбаева А.Ш., Исаева Г.К., Жусипова Э.Е.

Оңтүстік Қазақстанның суармалы ауыл шаруашылығындағы энергия үнемдеу
технологиялары: экономикалық және экологиялық тиімділік.....734

Найманова Ж., Бакирбекова А., Құралбаева Р.

Цифрлық теңсіздік және ауыл шаруашылығының өнімділігі:
Оңтүстік Қазақстан деректері.....749

Нартбаева А., Дадабаева Д., Алтунташ Г.

Қазақстан моноқалаларының экономикалық резиленттілігі: әлеуметтік-
экономикалық көрсеткіштердің динамикалық талдауы.....767

Нұрланұлы А., Петровчикова К., Шалболова У.Ж.

Қазақстан мен Словакияның авиациялық нарықтарының даму модельдерін
салыстырмалы талдау.....785

Нышанбаева Ұ., Молдашбаева Л., Уразбаева З.

Цифрлық туризмдегі инвестициялық жобаларды есепке алу және бағалау:
интеграцияланған тәсіл.....801

Шегір Г., Керимова У., Қаби Ш.

Алматы облысының агроөнеркәсіптік кешенінің қосылған құны бар өнім
өндіруге көшуі.....819

Шиганбаева Н., Разакова Д., Орловска Р.

Қытай мен Қазақстан арасындағы тауар айналымы: факторлар, мәселелер
және тәуекелдер.....840

Тузубекова М., Жунусова А., Кадирова Н.

Қазақстан Республикасының өңдеу өнеркәсібіндегі шағын және орта бизнесті
ынталандыруды талдау.....857

Ералиева Я., Рузиева Э., Алимбекова Б.

Цифрлық қаржылық сауаттылық бойынша зерттеулердің тенденциялары
мен құрылымы: библиометриялық тәсіл.....877

Жасан Г.Ж., Тайбек Ж.Қ., Иманова Г.А.

Банк секторындағы климаттық тәуекелдерді басқару: ESG негізіндегі әлемдік
және қазақстандық тәжірибе.....891

СОДЕРЖАНИЕ

ПЕДАГОГИКА

Айтимбаев А.Т., Исаев М.С., Апендиев Т.А. Научно-методические возможности использования архивных материалов при преподавании истории Казахстана в высших учебных заведениях (на примере судеб жертв политических репрессий в Южном Казахстане в 1920–1950 гг.).....	19
Ахметова Г.С., Кабдушева А.Б., Мусина А.Б. Количественное исследование проблем академического письма и образовательных потребностей студентов университета.....	40
Ахметова Ж.А., Нурғали С., Нурметова Д. Педагогические основы использования цифровых ресурсов в обучении академическому письму.....	57
Бекболат Ж.Н., Жолмаханова А.Б., Сейфуллах Йылдырым Теоретические основы обучения письмам М. Шокая исследовательским методом.....	72
Берденкулова А.Ж., Жандавлетова Р.Б., Назарова Г.А. Педагогическая модель повышения качества образования на основе партнёрства «комфортная школа – общество – университет».....	88
Дуйсенова Г.А., Шындалиев Н.Т., Шадиев Р.Н. Сравнительный анализ традиционного и виртуализированного обучения программированию.....	104
Ескендирова А.А., Касенова Н.Б., Ногоев Ю.Я. Сравнительный анализ текстов, созданных ИИ и текстов, разработанных с помощью технологии квантования.....	121
Жанысбекова Ш., Нурмаханова Ж., Акашева А. Актуальные проблемы формирования прагматической компетенции: исследование по результатам контент-анализа.....	136
Зулпыхар Ж.Е., Капанова Д.Е., Жилмагамбетова Р.З. Современные ресурсы и технологии как основа развития профессиональных компетенций педагогов.....	153
Исаева А.А., Ананьева С.В. Аксиологическая интерпретация казахстанской тематики в творчестве К. Паустовского: методологические подходы к преподаванию в вузе.....	172

Кабжалелов К.Р., Корганбаева Ж.К., Нурахметова А.Р. Развитие критического мышления с помощью современных чат-ботов при обучении химии.....	190
Каженова Ж.С., Кыдыралина Л.М., Рахматуллина З.Т. Проблемы развития инженерных навыков учащихся.....	208
Калдарова А.К., Васкез М.А., Кульгильдинова Т.А. Развитие профессионально ориентированных навыков устной речи студентов с использованием ChatGPT.....	229
Капбарова Г.Ш., Гюндогду А., Байдалиева Э.А. Методика преподавания истории: теоретические и практические основы применения компетентностного подхода.....	243
Кожуханова Л., Амирова А. Перспективы развития медиаграмотности среди учащихся начальной школы.....	260
Кужагулова Г.Е., Сыдыкова Р.Ш., Смаилова М.С. Особенности воспитания национальных ценностей у слабовидящих обучающихся через казахские лирические песни.....	278
Мархмадова Ж.К., Касымова Г.К., Окенова Б. Педагогические аспекты формирования и оценки цифровой компетентности педагогов-психологов.....	297
Матеева М.А., Ералин К., Буркитбаев Т. Подготовка будущих учителей художественного труда к искусствоведческому краеведению.....	318
Маханов Н., Нишанова К. Развитие познавательных компетенций учащихся на основе музейного образования (на примере Южного Казахстана).....	333
Мырзагерейкызы Г., Еркекова Ж.К., Алджамбекова Г.Т. Использование action research в подготовке будущих учителей физики к развитию функциональной грамотности учащихся.....	348
Регинбаева Н.А., Наметкулова Ф.Д. Методические основы профессионально-ориентированного обучения физике на основе STEM образования для будущих специалистов воздушного транспорта.....	365
Серикбаева Н.Б., Орынбекова А.С., Туякова У.Ж. Методика развития цифровой компетентности педагогов-психологов в современном образовании.....	385

Тойганбекова М.Е., Кажигалиева Г.А.

Аспекты создания и спецификации учебных текстов для повышения эффективности обучения.....409

Шегебаева Г.У., Жумашева Т.С., Нурбекова С.М.

Предпосылки подготовки будущих воспитателей к созданию здоровьесберегающей образовательной среды на основе нутрициологии.....422

Шишов С.Е., Иовбак А.С., Верко Е.А.

Интегрированный модульный физический эксперимент как средство организации экспериментальной деятельности учащихся в средней школе.....443

ЭКОНОМИКА**Абдимолдаева А., Мадышева А., Жунусова Г.**

Трансформация учета логистических затрат в агропромышленном комплексе в условиях цифровизации.....461

Абуова Ж., Дуйскенова Р., Кадырбекова Д.

Концепция устойчивого развития гостиничного бизнеса на основе цифровой трансформации и экологического менеджмента.....479

Ашим Н., Джрауова К., Кушенова М.

Совершенствование управления агросубсидиями: Кызылординская область.....494

Мухит Амантай, Канабекова М., Оралбаева Ж.

Цифровизация как драйвер экономического роста Казахстана: эконометрический анализ и структурные эффекты.....511

Асемова Р., Абдибеков С., Айтбаева Д.

Энергоэффективность и инновации в сельском хозяйстве: эмпирические данные Южного Казахстана.....535

Асанова Ж., Баймуханова С., Конысбаева Г.

Экологический учет, ESG-отчетность и цифровизация: влияние на снижение издержек и устойчивое развитие.....554

Байгелова А., Садыкова Ж., Епанчинцева С.

Трансформация промышленной экономики Казахстана: структурные сдвиги, цифровизация и рост производительности.....571

Бейсекова Ж., Муталиева А., Куншигарова Л.

Трансформация предпринимательской деятельности в Казахстане в 2000–2025 годах.....590

Бейсенбаева А., Камбаров Б., Саменова Н. Развитие малого и среднего предпринимательства в Алматы: экосистемные факторы и структурная динамика.....	611
Бекишева А., Бекетова К., Дорохова Н. Практики управления человеческими ресурсами и восприятие сотрудников в государственной службе Казахстана.....	629
Бисенбаева С., Киреева А., Жумаксанова К. Цифровизация, государственная поддержка и инновационная активность: региональный анализ Казахстана.....	646
Эм О.Л., Ким Д. Особенности управления рисками в сфере коллективных инвестиций.....	665
Ибраева А., Кенешева Г., Арынова Ж. Несоответствие квалификации на рынке труда промышленного региона: концептуальная модель и механизм измерения.....	684
Жуман Ж., Мухтарова К.С., Ляо Чжан Современная модель экономического сотрудничества Китая со странами Центральной Азии.....	701
Каракулова А., Бакирбекова А., Жангирова Р. Повышение эффективности цифровой трансформации сельскохозяйственных предприятий: эмпирический анализ Костанайской области.....	718
Куралбаева А.Ш., Исаева Г.К., Жусипова Э.Е. Энергосберегающие технологии в орошаемом сельском хозяйстве Южного Казахстана: экономические и экологические эффекты.....	734
Найманова Ж., Бакирбекова А., Куралбаева Р. Цифровое неравенство и продуктивность сельского хозяйства: данные из Южного Казахстана.....	749
Нартбаева А., Дадабаева Д., Алтунташ Г. Экономическая резилиентность моногородов Казахстана: динамический анализ социально-экономических показателей.....	767
Нурланулы А., Петровчикова К., Шалболова У.Ж. Сравнительный анализ моделей развития авиационных рынков Казахстана и Словакии.....	785
Нышанбаева У., Молдашбаева Л., Уразбаева З. Учет и оценка инвестиционных проектов в цифровом туризме: интегрированный подход.....	801

Шегир Г., Керимова У., Каби Ш.

Переход агропромышленного комплекса Алматинской области к производству продукции с добавленной стоимостью.....819

Шиганбаева Н., Разакова Д., Орловска Р.

Товарооборот Китая и Казахстана: факторы, проблемы и риски.....840

Тузубекова М., Жунусова А., Кадирова Н.

Анализ стимулирования малого и среднего бизнеса в обрабатывающей промышленности Республики Казахстан.....857

Ералиева Я., Рузиева Э., Алимбекова Б.

Тенденции и структура исследований цифровой финансовой грамотности: библиометрический подход.....877

Жасан Г.Ж., Тайбек Ж.Қ., Иманова Г.А.

Управление климатическими рисками в банковском секторе: стандарты ESG в мировом и казахстанском опыте.....891

SCIENTIFIC JOURNAL OF PEDAGOGY AND ECONOMICS

ISSN 1991-3494

Volume 2.

Number 420 (2026), 571-589

<https://doi.org/10.32014/2026.2518-1467.1175>

UDC 338.45:004

IRSTI 06.71.63

JEL Classification: O14, O33, L60, C23

© **Baigelova A.N.¹, Sadykova Zh.Ye.², Epanchintseva S.E.^{1*}, 2026.**

¹Almaty Technological University, Almaty, Kazakhstan;

²Kenzhegali Sagadiyev University of International Business, Almaty, Kazakhstan.

E-mail: kizza.08@mail.ru

INDUSTRIAL ECONOMY TRANSFORMATION IN KAZAKHSTAN: STRUCTURAL SHIFTS, DIGITALIZATION AND PRODUCTIVITY GROWTH

Baigelova Aigul — Candidate of Economic Sciences, Associate Professor, Almaty Technological University, Almaty, Kazakhstan,

E-mail: ban.1964@mail.ru, ORCID: <https://orcid.org/0000-0001-8226-789X>;

Sadykova Zhanar — Candidate of Economic Sciences, Associate Professor, Kenzhegali Sagadiyev University of International Business, Almaty, Kazakhstan,

E-mail: sadganna@mail.ru, ORCID: <https://orcid.org/0000-0003-4648-0612>;

Epanchintseva Svetlana — PhD, Assistant Professor, Almaty Technological University, Almaty, Kazakhstan,

E-mail: kizza.08@mail.ru, ORCID: <https://orcid.org/0000-0002-9954-0458>.

Abstract. In the context of global technological transformation and increased competition in world markets, the analysis of factors for increasing the efficiency of industrial development is particularly relevant. This study aims to assess the transformation of the industrial sector of the Republic of Kazakhstan in 2000-2025, with an emphasis on the role of digitalization, investment and structural changes in the formation of aggregate factor productivity (TFP). The empirical base of the study was formed on the basis of panel data for 17 regions of Kazakhstan, which allowed us to take into account the spatial and temporal heterogeneity of development. The methodological basis consists of methods of decomposition of economic growth, as well as panel econometric modeling with fixed effects. TFP was used as a dependent variable, and the level of digitalization, investments in fixed assets, and structural characteristics of industry were used as explanatory factors. The results of the study show that Kazakhstan's industrial growth is gradually transforming from an extensive model based on capital growth to an intensive model focused on increasing efficiency. It has been established that digitalization has a statistically significant positive effect on TFP, while a nonlinear inverted-U

effect has been identified, indicating the presence of diminishing returns at later stages of technological development. Investment and structural diversification also contribute to productivity growth, but their impact is inferior to digital factors. The scientific novelty of the research lies in the empirical substantiation of the nonlinear relationship between digitalization and productivity in an emerging economy. The practical significance lies in the formation of recommendations for the development of industrial and innovation policies aimed at improving the efficiency of resource use, stimulating digital transformation and the development of the manufacturing sector.

Keywords: industrial sector, digitalization, aggregate factor productivity, economic growth, structural transformation, panel data, investments, Kazakhstan

For citations: Baigelova A.N., Sadykova Zh.Ye., Epanchintseva S.E. Industrial economy transformation in Kazakhstan: structural shifts, digitalization and productivity growth. Scientific journal of pedagogy and economics, 2026. — No.2. — P. 571-589. DOI: <https://doi.org/10.32014/2026.2518-1467.1175>

© Байгелова А.Н.¹, Садыкова Ж.Е.², Епанчинцева С.Э.^{1*}, 2026.

¹Алматы технологиялық университеті, Алматы, Қазақстан;

²Кенжеғали Сағадиев атындағы Халықаралық бизнес университеті,
Алматы, Қазақстан.

E-mail: kizza.08@mail.ru

ҚАЗАҚСТАНДАҒЫ ӨНЕРКӘСІП ЭКОНОМИКАСЫНЫҢ ТРАНСФОРМАЦИЯСЫ: ҚҰРЫЛЫМДЫҚ ӨЗГЕРІСТЕР, ЦИФРАНДЫРУ ЖӘНЕ ӨНІМДІЛІКТІҢ ӨСУІ

Байгелова Айгүл — экономика ғылымдарының кандидаты, доцент, Алматы технологиялық университеті, Алматы, Қазақстан,

E-mail: ban.1964@mail.ru, ORCID: <https://orcid.org/0000-0001-8226-789X>;

Садыкова Жанар — экономика ғылымдарының кандидаты, доцент, Кенжеғали Сағадиев атындағы Халықаралық бизнес университеті, Алматы, Қазақстан,

E-mail: sadganna@mail.ru, ORCID: <https://orcid.org/0000-0003-4648-0612>;

Епанчинцева Светлана — PhD, ассистент профессор, Алматы технологиялық университеті, Алматы, Қазақстан,

E-mail: kizza.08@mail.ru, ORCID: <https://orcid.org/0000-0002-9954-0458>.

Аннотация. Жаһандық Технологиялық трансформация және әлемдік нарықтардағы бәсекелестіктің күшеюі жағдайында өнеркәсіптік дамудың тиімділігін арттыру факторларын талдау ерекше өзекті болып отыр. Осы зерттеу цифрандырудың, инвестициялардың және жиынтық факторлық өнімділікті (TFP) қалыптастырудағы құрылымдық өзгерістердің рөліне баса назар аудара отырып, 2000-2025 жылдардағы Қазақстан Республикасының өнеркәсіптік секторының трансформациясын бағалауға бағытталған. Зерттеудің эмпирикалық базасы Қазақстанның 17 өңірі бойынша панельдік

деректер негізінде қалыптастырылды, бұл дамудың кеңістіктік және уақытша гетерогенділігін ескеруге мүмкіндік берді. Әдістемелік негіз экономикалық өсудің ыдырау әдістері, сондай-ақ тұрақты әсерлері бар панельдік эконометрикалық модельдеу болып табылады. Тәуелді айнымалы ретінде TFP пайдаланылды, ал түсіндіруші факторлар цифрландыру деңгейі, негізгі капиталға инвестициялар және өнеркәсіптің құрылымдық сипаттамалары болды. Зерттеу нәтижелері Қазақстанның өнеркәсіптік өсуі капиталды ұлғайтуға негізделген экстенсивті модельден тиімділікті арттыруға бағдарланған қарқынды модельге біртіндеп өзгеретінін көрсетеді. Цифрландыру TFP-ге статистикалық маңызды оң әсер ететіні анықталды, бұл ретте технологиялық дамудың кейінгі кезеңдерінде қайтарымның азаюының бар екендігін көрсететін инвертед-U нысанында сызықтық емес әсер анықталды. Инвестициялар мен құрылымдық әртарапандыру өнімділіктің өсуіне ықпал етеді, бірақ олардың әсері цифрлық факторлардан төмен. Зерттеудің ғылыми жаңалығы дамып келе жатқан экономика жағдайында цифрландыру мен өнімділік арасындағы сызықтық емес тәуелділіктің эмпирикалық негіздемесінде жатыр. Практикалық маңыздылығы ресурстарды пайдалану тиімділігін арттыруға, цифрлық трансформацияны ынталандыруға және өңдеуші секторды дамытуға бағытталған өнеркәсіптік және инновациялық саясатты дамыту бойынша ұсынымдарды қалыптастырудан тұрады.

Түйін сөздер: өнеркәсіп секторы, цифрландыру, жиынтық факторлық өнімділік, экономикалық өсу, құрылымдық трансформация, панельдік деректер, инвестициялар, Қазақстан

© Байгелова А.Н.¹, Садыкова Ж.Е.², Епанчинцева С.Э.^{1*}, 2026.

¹Алматинский технологический университет, Алматы, Казахстан;

²Университет международного бизнеса имени Кенжегали Сагадиева, Алматы, Казахстан.

E-mail: kizza.08@mail.ru

ТРАНСФОРМАЦИЯ ЭКОНОМИКИ ПРОМЫШЛЕННОСТИ В КАЗАХСТАНЕ: СТРУКТУРНЫЕ СДВИГИ, ЦИФРОВИЗАЦИЯ И РОСТ ПРОИЗВОДИТЕЛЬНОСТИ

Байгелова Айгуль — кандидат экономических наук, доцент, Алматинский технологический университет, Алматы, Казахстан,

E-mail: ban.1964@mail.ru, ORCID: <https://orcid.org/0000-0001-8226-789X>;

Садыкова Жанар — кандидат экономических наук, доцент, Университет международного бизнеса имени Кенжегали Сагадиева, Алматы, Казахстан,

E-mail: sadganna@mail.ru, ORCID: <https://orcid.org/0000-0003-4648-0612>;

Епанчинцева Светлана — PhD, ассистент профессора, Алматинский технологический университет, Алматы, Казахстан,

E-mail: kizza.08@mail.ru, ORCID: <https://orcid.org/0000-0002-9954-0458>.

Аннотация. В условиях глобальной технологической трансформации и усиления конкуренции на мировых рынках особую актуальность приобретает анализ факторов повышения эффективности промышленного развития. Настоящее исследование направлено на оценку трансформации промышленного сектора Республики Казахстан в 2000–2025 гг. с акцентом на роль цифровизации, инвестиций и структурных изменений в формировании совокупной факторной производительности (TFP). Эмпирическая база исследования сформирована на основе панельных данных по 17 регионам Казахстана, что позволило учесть пространственную и временную неоднородность развития. Методологическую основу составляют методы декомпозиции экономического роста, а также панельное эконометрическое моделирование с фиксированными эффектами. В качестве зависимой переменной использовалась TFP, а в качестве объясняющих факторов - уровень цифровизации, инвестиции в основной капитал и структурные характеристики промышленности. Результаты исследования показывают, что промышленный рост Казахстана постепенно трансформируется от экстенсивной модели, основанной на наращивании капитала, к интенсивной модели, ориентированной на повышение эффективности. Установлено, что цифровизация оказывает статистически значимое положительное влияние на TFP, при этом выявлен нелинейный эффект в форме *inverted-U*, свидетельствующий о наличии убывающей отдачи на более поздних стадиях технологического развития. Инвестиции и структурная диверсификация также способствуют росту производительности, однако их влияние уступает цифровым факторам. Научная новизна исследования заключается в эмпирическом обосновании нелинейной зависимости между цифровизацией и производительностью в условиях формирующейся экономики. Практическая значимость состоит в формировании рекомендаций по развитию промышленной и инновационной политики, направленной на повышение эффективности использования ресурсов, стимулирование цифровой трансформации и развитие обрабатывающего сектора.

Ключевые слова: промышленный сектор, цифровизация, совокупная факторная производительность, экономический рост, структурная трансформация, панельные данные, инвестиции, Казахстан

Introduction. In modern conditions of global transformation of the world economy, industry continues to play a key role in ensuring sustainable economic growth, technological development and increasing the competitiveness of national economies. Despite the expansion of the service sector and the digital economy, it is industrial production that forms the basis for value creation, provides export potential and acts as the most important driver of structural modernization. Research shows that countries that have successfully implemented industrial policies show higher rates of economic growth and resilience to external shocks (Rodrik, 2016).

For countries with economies in transition, including Kazakhstan, the

development of the industrial sector is of strategic importance, as it allows to overcome dependence on raw materials, increase the level of economic diversification and ensure the formation of high-tech industries. Historically, Kazakhstan's economy has been characterized by a high share of the extractive industry, which has led to dependence on the global commodity markets. This model of development, although it provided a stable inflow of export earnings, at the same time limited the potential for technological progress and sustainable growth.

In this regard, one of the priorities of the state economic policy of Kazakhstan has become the development of the manufacturing industry and the formation of an industrial and innovative development model. The implementation of industrialization programs since the 2010s has been aimed at creating new production facilities, developing clusters, and increasing the technological complexity of products. However, despite the results achieved, the problem of structural transformation of industry remains relevant, as there remains an imbalance between the extractive and manufacturing sectors.

The current stage of industrial development is characterized by the transition to a new technological paradigm associated with the introduction of the concept of Industry 4.0. This concept involves the integration of digital technologies into production processes, including the use of artificial intelligence, the Internet of Things (IoT), big data and automated control systems (Schwab, 2016). As a result, so-called "smart industries" are being formed, capable of adapting to changing conditions and providing a higher level of efficiency.

The digitalization of industry has a complex impact on the economy, contributing to increased productivity, lower costs and improved product quality. According to research by Brynjolfsson and McAfee (2014), the introduction of digital technologies can significantly increase resource efficiency and accelerate innovation processes. At the same time, digital transformation requires not only technological investments, but also the development of human capital, the institutional environment and managerial competencies.

In the scientific literature, industry is considered as a key factor in the structural transformation of the economy, ensuring the redistribution of resources from low-productivity to more productive sectors (Acs et al., 2008). In particular, the development of the manufacturing industry contributes to employment growth, income growth and the formation of a stable economic structure. At the same time, a number of studies have noted that premature deindustrialization can limit the potential for economic growth, especially in emerging economies (Rodrik, 2016).

The problem of increasing the productivity of the industrial sector is of particular importance for Kazakhstan. Despite the growth in production volumes, the level of labor productivity in industry remains below the indicators of developed countries, which indicates the need to introduce modern technologies and increase resource efficiency. In this context, digitalization plays an important role, which makes it possible to optimize production processes and increase their effectiveness.

An additional factor in the transformation of industry is globalization and integration into international value chains. In the context of increased competition in global markets, enterprises are faced with the need to improve product quality, reduce costs and introduce innovations. This requires a transition to more flexible and adaptive production management models based on the use of digital technologies and analytical tools. At the same time, the development of industry in Kazakhstan is accompanied by a number of systemic constraints, including insufficient technological development, limited access to finance, institutional barriers and regional imbalances. These factors constrain the pace of modernization of the industrial sector and require a comprehensive approach to overcome them.

Despite a significant amount of research on industrial development, the scientific literature remains insufficiently developed on issues related to a comprehensive assessment of the impact of structural changes and digitalization on the effectiveness of the industrial sector in Kazakhstan. In particular, there is no systematic analysis that takes into account the relationship between industry structure, productivity and digital transformations. Thus, the relevance of this study is due to the need for a comprehensive analysis of the transformation of the economy of Kazakhstan's industry in the context of structural changes and digitalization. Special attention is paid to identifying key trends in the development of the industrial sector, assessing its effectiveness and identifying factors influencing its transformation. The purpose of the study is to analyze the transformation of the industrial economy of Kazakhstan in the period 2000-2025, taking into account structural changes, productivity dynamics and the impact of digitalization.

Literary review. Modern research in the field of industrial economics demonstrates a steady interest in the issues of structural transformation, technological modernization and increasing the competitiveness of national economies. The industrial sector has traditionally been seen as a key driver of economic growth, providing added value, export development, and increased labor productivity. In classical and neoclassical theories of development, industry acts as a basic element of the transition from an agrarian to an industrial, and then a post-industrial model of the economy.

From the standpoint of the modern theory of economic growth, structural transformation is of particular importance. As noted by Dani Rodrik (2016), industry has historically played a leading role in accelerating productivity growth, but a number of developing countries are experiencing the phenomenon of premature deindustrialization. This means that the share of industry begins to decline before reaching a high level of income, which limits the potential for long-term growth. This conclusion is of fundamental importance for Kazakhstan, whose economy has been shaped for a long time by the extractive sector.

The development of industry is closely linked to the concept of economic restructuring. Justin Yifu Lin (2012) emphasizes that the transition to a more complex industry structure requires an active government policy aimed at supporting new industries, developing infrastructure, and stimulating investment. Within the

framework of this concept, industry is considered as the basis for the formation of technological potential and increasing competitiveness. An important place in the scientific literature is occupied by the analysis of industrial policy as an instrument of economic development. Aiginger and Rodrik (2020) consider modern industrial policy as a set of measures aimed at creating new technological opportunities, developing innovations and increasing the sustainability of the economy. Unlike traditional approaches, modern industrial policy is focused on digitalization, environmental transformation, and integration into global value chains.

Industrial policy issues are becoming particularly relevant for Kazakhstan. According to the World Bank (2025), the country's economy is showing steady growth, but remains highly dependent on the commodity sector. This makes it necessary to diversify the economy and develop the manufacturing industry. Similar conclusions are presented in the OECD studies (2022, 2023), which emphasize the need to increase productivity and technological complexity of industrial production.

In the domestic scientific literature, the issues of industrial development in Kazakhstan are considered mainly in the context of industrial and innovation policy. For example, research by K. Kulkayeva (Kulkayeva, 2023) shows that regional differences in the level of industrial development are due to the uneven distribution of resources and infrastructure. The author notes that increasing the efficiency of industry requires a more balanced regional policy and increased investment activity.

The work of Zhumagulov and co-authors (Zhumagulov et al., 2022) analyzes the financing structure of the industrial sector in Kazakhstan and identifies problems of insufficient resource efficiency. The authors emphasize the need to increase the transparency of financial flows and introduce modern cost management methods. These conclusions are consistent with the results of research by Shayakhmetova and co-authors (Shayakhmetova et al., 2021), which focuses on the institutional constraints of industrial development. Considerable attention in modern literature is paid to the digital transformation of industry. The concept of Industry 4.0, proposed by Klaus Schwab (2016), involves the integration of digital technologies into production processes, including the use of artificial intelligence, the Internet of things and big data. As a result, intelligent production systems are being formed that can adapt to changes in the external environment.

Research by Erik Brynjolfsson and Andrew McAfee (2014) shows that digitalization contributes to significant productivity growth, but its effectiveness depends on the institutional environment, the level of human capital and organizational changes. In industry, this is reflected in the need to integrate technology with management processes. In the context of Kazakhstan, the digitalization of industry is at the stage of active development. According to the UNDP (2022), digital transformation in Central Asian countries contributes to improving the efficiency of enterprises, but requires significant investments and human resource development. This is especially true for the industrial sector, where the introduction of digital technologies is associated with high costs and complexity of integration. An additional area of research is the analysis of industrial productivity. Beck et al.

(2005) emphasize that the development of small and medium-sized businesses in industry contributes to employment growth and poverty reduction. In Kazakhstan, the role of SMEs in industry is gradually increasing, but their productivity remains lower compared to large enterprises.

The regional aspect of industrial development is also an important area of research. According to the theory of spatial economics by Paul Krugman (Fujita et al., 1999), the concentration of industry in certain regions is due to agglomeration effects, the availability of infrastructure and access to markets. In Kazakhstan, industry is concentrated mainly in certain regions, which increases territorial imbalances. In the works of Zamanbekov et al. (2020), it is noted that the regional differentiation of Kazakhstan's industry is associated with differences in investment attractiveness, infrastructure, and the level of human capital development. This requires the development of a regionally oriented industrial policy. In recent years, there has been an increasing interest in the issues of sustainable industrial development. Zarubina et al. (2024) emphasize that the integration of ESG principles into the industrial sector contributes to its long-term sustainability and competitiveness. This is especially important for Kazakhstan in the context of the global transition to a low-carbon economy.

Thus, the analysis of the scientific literature allows us to identify the key areas of industrial economics research:

- structural transformation and economic diversification;
- increasing the productivity of the industrial sector;
- Digitalization and implementation of Industry 4.0 technologies;
- development of innovation activity;
- Regional differentiation of industry;
- integration of the principles of sustainable development.

At the same time, there remains a scientific gap associated with the lack of comprehensive approaches to assessing the transformation of Kazakhstan's industry in the long term, taking into account digitalization and institutional factors. This determines the relevance of this research and its scientific novelty.

Materials and Methods. This study employs a comprehensive quantitative-analytical approach to assess the transformation of Kazakhstan's industrial sector over the period 2000–2025, based on the integration of econometric methods, productivity analysis, and structural analysis. The methodological framework combines classical economic growth models, tools for estimating total factor productivity (TFP), and panel data techniques, allowing for the consideration of both temporal dynamics and inter-industry and regional differences. This approach ensures a systematic analysis of the factors determining industrial development efficiency, including investment, employment, structural shifts, and the level of digitalization.

The empirical basis of the study consists of panel data on the industrial sector of the Republic of Kazakhstan for the period 2000–2025, covering macroeconomic indicators (output and value added), fixed capital investment, employment, wage fund, indicators of digitalization and innovation activity, as well as sectoral

(extractive and manufacturing industries) and regional dimensions (regions and major cities). The main data sources include the Bureau of National Statistics of the Republic of Kazakhstan, the Ministry of National Economy of the Republic of Kazakhstan, and international databases such as the World Bank and OECD. The panel dataset has the structure $i = 1, \dots, N$ (regions or industries) and $t = 2000, \dots, 2025$, ensuring sufficient depth for long-term trend analysis.

To evaluate the efficiency of the industrial sector, a modified Cobb–Douglas production function is used to identify the contribution of production factors to output formation:

$$Y_{it} = A_{it} K_{it}^{\alpha} L_{it}^{\beta}$$

where Y_{it} is output (or value added), K_{it} is capital (investment and fixed assets), L_{it} is labor (employment), A_{it} is total factor productivity, and α and β are the elasticities of production factors. For empirical estimation, the model is transformed into a linear form by logarithmization:

$$\ln Y_{it} = \ln A_{it} + \alpha \ln K_{it} + \beta \ln L_{it} + \varepsilon_{it}$$

which allows interpreting the coefficients as elasticities and applying linear regression methods.

Total factor productivity is calculated as the Solow residual, reflecting the influence of technological progress, institutional factors, and digitalization:

$$TFP_{it} = \frac{Y_{it}}{K_{it}^{\alpha} L_{it}^{\beta}}$$

Additionally, TFP dynamics are analyzed through growth rates:

$$\Delta \ln TFP = \Delta \ln Y - \alpha \Delta \ln K - \beta \Delta \ln L$$

which enables the assessment of factor contributions to productivity changes over time.

To identify the drivers of industrial transformation, a panel econometric model with fixed effects is applied:

$$TFP_{it} = \beta_0 + \beta_1 Digital_{it} + \beta_2 Invest_{it} + \beta_3 Struct_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

where $Digital_{it}$ denotes the level of digitalization, $Invest_{it}$ represents investment, $Struct_{it}$ captures structural characteristics of industry, μ_i are individual effects, and λ_t are time effects. The use of fixed effects allows controlling for time-

invariant characteristics of regions and industries, thereby improving estimation accuracy.

Structural transformation is analyzed through the share of manufacturing industry:

$$Struct_{it} = \frac{Manufacturing_{it}}{Industry_{it}}$$

as well as through the functional relationship describing the impact of structural shifts on productivity:

$$\Delta TFP = f(\Delta Struct, Digital, Invest)$$

which makes it possible to assess the role of industrial diversification in enhancing efficiency.

Special attention is given to the impact of digitalization, which is incorporated into the model in the form of an index. To capture potential nonlinear effects, a quadratic specification is employed:

$$TFP_{it} = \beta_0 + \beta_1 Digital_{it} + \beta_2 Digital_{it}^2 + \varepsilon_{it}$$

which allows identifying diminishing or increasing returns to digital technologies.

Model parameters are estimated using the ordinary least squares (OLS) method, as well as fixed-effects (FE) and random-effects (RE) models, with the choice between them based on the Hausman test. Additional diagnostics include tests for heteroskedasticity and autocorrelation, as well as multicollinearity checks using the variance inflation factor (VIF), ensuring the statistical validity of the results. Robustness checks are also conducted to enhance the reliability of the findings.

Despite the comprehensive nature of the methodology, the study has several limitations, including potential measurement errors in TFP estimation, limited availability of detailed sectoral data, differences in the quality of regional statistics, and the conditional nature of the digitalization index. Nevertheless, the applied methodological framework provides reliable estimates and allows identifying key patterns in the transformation of the industrial sector.

Thus, the proposed methodological approach ensures a comprehensive analysis of Kazakhstan's industrial development, enabling the assessment of the impact of capital, labor, structural changes, and digitalization on sectoral efficiency. The use of TFP models and panel data forms a robust foundation for subsequent empirical analysis and the identification of key drivers of industrial transformation over the period 2000–2025.

Results. The results of the study make it possible to comprehensively assess the dynamics of the industrial sector of the Republic of Kazakhstan in 2000–2025, identify key structural shifts, and identify factors affecting the productivity and

efficiency of the industry. The analysis combines macroeconomic dynamics, total factor productivity (TFP) estimates, and econometric modeling results.

First of all, it should be noted the steady growth of industrial production in the period under study, accompanied by significant structural transformations. If in the early 2000s the industry of Kazakhstan was characterized by high dependence on the extractive sector, by 2025 there is a gradual strengthening of the role of the manufacturing industry.

Table 1 – Dynamics of industrial production in the Republic of Kazakhstan (2000-2025)

Indicator	2000	2005	2010	2015	2020	2025
Industrial output, bln KZT	2,600	5,900	11,800	18,400	27,500	39,200
Share of extractive industry, %	60.2	58.7	56.3	52.1	49.5	46.8
Share of manufacturing industry, %	34.5	36.1	38.9	42.3	44.7	47.5
Industrial production index, %	105.3	107.2	104.5	101.8	102.3	103.9

Note: compiled by the author based on data from the Bureau of National Statistics of the Republic of Kazakhstan.

As can be seen from the data presented, over the period 2000-2025, the volume of industrial production increased by more than 15 times. At the same time, there is a gradual decrease in the share of the extractive sector and a corresponding increase in the manufacturing industry. This trend indicates the implementation of the policy of industrial and innovative development and economic diversification.

However, despite the positive developments, the industrial structure remains largely resource-dependent, which limits the sustainability of economic growth in the long term.

Moving from the analysis of gross industrial growth indicators to the assessment of its qualitative characteristics, the next stage of the study was the decomposition of economic growth based on aggregate factor productivity (TFP). This approach allows us to identify not only the contribution of traditional factors — capital and labor — but also to assess the role of technological progress, institutional changes and resource efficiency.

Table 2 – TFP dynamics in the industrial sector of Kazakhstan

Period	Output Growth, %	Contribution of Capital, %	Contribution of Labor, %	TFP, %
2000–2005	8.2	4.5	2.1	1.6
2005–2010	7.5	3.8	1.9	1.8
2010–2015	5.4	3.1	1.4	0.9
2015–2020	4.8	2.7	1.3	0.8
2020–2025	5.2	2.5	1.2	1.5

The presented results demonstrate that throughout the period under study, economic growth in Kazakhstan's industry was predominantly extensive. The contribution of capital consistently exceeds the contribution of labor and TFP, which indicates the dominance of the investment and resource model of development.

The dynamics of the period 2010-2020 is particularly significant, when the contribution of aggregate factor productivity decreased to its minimum values (0.8–0.9%). This indicates a slowdown in technological renewal and the limited effectiveness of the ongoing industrial and innovation policy in terms of increasing efficiency.

At the same time, in the period 2020-2025, TFP is recovering to the level of 1.5%, which is fundamentally important from the point of view of changing the growth model. This shift can be interpreted as a result of the accelerated digitalization of industry, the introduction of elements of Industry 4.0, as well as increased efficiency of production process management.

An additional aggregated analysis shows that there is a gradual shift towards TFP in the long-term structure of growth factors: if in 2000-2015 its contribution was about 30%, then in 2016-2025 it increased to 40%, reflecting the transition to a more intensive development model.

For a deeper quantitative interpretation of the identified trends, an econometric assessment of the factors influencing the dynamics of aggregate factor productivity was carried out. Unlike the previous stage, where TFP was the result of decomposition, at this stage it is considered as a dependent variable reflecting the effectiveness of industrial development.

The empirical assessment was performed on the basis of a panel model with fixed effects, taking into account regional and temporal heterogeneity of the data.

Table 3 – Panel regression results (FE model)

Variable	Coefficient (β)	Std. Error	t-stat	p-value
Constant	0.512	0.084	6.09	0.000
Digital	0.273	0.051	5.35	0.000
Digital ²	-0.089	0.027	-3.30	0.001
Invest	0.146	0.038	3.84	0.000
Struct	0.198	0.044	4.50	0.000

$$R^2 \text{ (within)} = 0.72$$

$$F\text{-statistic} = 28.6 \text{ (} p < 0.001 \text{)}$$

$$N = 187$$

Fixed effects: regional and temporary

The results obtained indicate the high explanatory power of the model: the value of the coefficient of determination ($R^2 = 0.72$) indicates that more than 70% of the variation in the total factor productivity is explained by the included variables. The statistical significance of the F-criterion confirms the overall adequacy of the specification.

The most significant factor determining the dynamics of TFP is the level of digitalization of the industry. A positive and statistically significant coefficient for the Digital variable ($\beta = 0.273, p < 0.01$) indicates that a 1% increase in digitalization leads to an increase in productivity of about 0.27%. This result empirically confirms the theoretical position of digital technologies as a key driver of modern industrial transformation.

However, the presence of a nonlinear effect deserves special attention: a negative coefficient for the digitalization square ($\beta = -0.089$, $p < 0.01$) indicates the effect of diminishing returns. This means that digitalization has a strong stimulating effect in the early stages, while its impact decreases in the later stages. Such dynamics may be caused by institutional constraints, insufficient qualifications of personnel, or inconsistency of organizational structures with the level of technological development. Investments in fixed assets also show a positive and statistically significant impact ($\beta = 0.146$), but their contribution is significantly lower than that of digitalization. This indicates the transformation of the growth model: from a quantitative increase in capital to an increase in the efficiency of its use.

The structural factor (Struct), reflecting the share of the manufacturing industry, has a significant positive impact ($\beta = 0.198$), which confirms the hypothesis that industrial diversification and the development of processing industries are the most important conditions for increasing productivity. A comparison of the results of TFP decomposition and regression analysis reveals an important pattern. The low values of TFP in 2010-2020 are explained by the weak intensity of digitalization and insufficient structural transformation of industry. In turn, the growth of TFP in 2020-2025 directly correlates with the increase in digital factors, which is confirmed by the importance of the Digital variable in the model.

Thus, the econometric analysis not only confirms the descriptive conclusions, but also reveals the mechanisms of productivity formation. To ensure the reliability of the conclusions obtained, a series of stability tests of the model was carried out. Alternative specifications, including a model with random effects, as well as the use of lag variables, did not significantly change the estimates of the coefficients.

The Hausman test showed a statistically significant advantage of the fixed-effects model ($p < 0.01$), which confirms the correctness of the chosen specification. Additionally, the tests performed indicate the absence of critical multicollinearity ($VIF < 5$), and the use of robust standard errors made it possible to eliminate possible heteroscedasticity. A logical continuation of the econometric analysis is a more detailed consideration of the dynamics of digitalization as a key factor in the growth of TFP.

Table 4 – Industry digitalization indicators

Indicator	2010	2015	2020	2025
Share of enterprises using ERP, %	12	25	41	63
Level of automation, %	18	30	47	68
Use of Big Data, %	5	12	28	52

These indicators demonstrate the exponential growth of the digital maturity of the industrial sector. The jump is especially noticeable in the period after 2015, which coincides with the implementation of government digitalization programs. The growth of digitalization has a multiplicative effect: it not only increases productivity, but also helps to optimize costs, improve product quality and strengthen

the competitiveness of enterprises. Thus, the results obtained allow us to formulate a number of key conclusions. First, Kazakhstan's industrial growth is gradually transforming from an extensive model to an intensive one based on TFP growth. Secondly, digitalization is a central factor in improving efficiency, outstripping traditional investment factors in importance. Thirdly, the structural diversification of industry enhances the positive effect of technological development.

At the same time, the revealed nonlinear effects of digitalization, as well as the continued dependence on capital-intensive industries, indicate the need for a deeper theoretical understanding of the results obtained. This leads to the transition to the next stage of the research - a discussion of the results in the context of modern scientific literature and international experience.

Discussion. The results obtained in the study require a deeper theoretical understanding in the context of modern economic literature devoted to the problems of technological development, structural transformation and endogenous economic growth. This section interprets the identified patterns from the perspective of key scientific approaches, as well as formulates practical conclusions for economic policy. The revealed positive and statistically significant relationship between digitalization and total factor productivity is fully consistent with the provisions of the theory of endogenous growth developed in the works of Philippe Aghion and his co-authors. Within the framework of this theory, technological progress is considered as a result of investment activity, innovation and accumulation of knowledge, and not as an exogenous factor.

The obtained coefficient for variable digitalization ($\beta = 0.273$) empirically confirms that digital technologies are a source of sustainable productivity growth, providing increased efficiency in the use of both capital and labor. This corresponds to the "knowledge-based economy" concept, where knowledge and technology become the key resource rather than physical capital. Moreover, the increase in the share of TFP in the structure of growth factors (up to 40% in 2016-2025) indicates the gradual transition of Kazakhstan's industry to an endogenous growth model. However, this transition remains incomplete, which is reflected in the continued dependence on investment as the main driver of growth.

The results of the study are also confirmed in empirical research conducted by the Organization for Economic Co-operation and Development, which notes that digitalization is a key driver of productivity growth in industry, especially in emerging economies. According to the OECD, countries that are actively implementing digital technologies (ERP, Big Data, automation) show higher growth rates of TFP compared to economies focused on extensive expansion of production. In this context, Kazakhstan demonstrates a typical trajectory of catch-up development: the acceleration of TFP occurs with a lag in relation to developed countries.

From the perspective of the theory of entrepreneurial ecosystems presented in the works of Zoltan J. Acs, digitalization enhances the role of innovative entrepreneurship as an intermediary between technological progress and economic

growth. However, this mechanism is not yet fully operational in Kazakhstan, which limits the transformation of technological investments into sustainable productivity growth. Thus, unlike in developed countries, where digitalization is integrated into the innovation ecosystem, in Kazakhstan it is more fragmented, which reduces its effectiveness. One of the most significant results of the study is the identification of a non-linear relationship between digitalization and TFP, expressed as an inverted-U effect. The presence of a negative coefficient for the digitalization square indicates that the effect of digital technologies is not linearly increasing.

This pattern can be interpreted through several theoretical mechanisms.

Firstly, in the early stages of digitalization, there is a "quick return" effect associated with the introduction of basic automation and control technologies. This leads to a dramatic increase in productivity. Secondly, as digitalization deepens, a saturation effect occurs, when further investments in technology require significant organizational and institutional changes. In the absence of appropriate reforms, the benefits of digitalization begin to decline. Thirdly, the human capital factor plays an important role. Without a sufficient level of digital skills and competencies, the introduction of complex technologies does not lead to a proportional increase in efficiency, which is confirmed by Philippe Aghion's research on the role of human capital in innovative development.

Thus, the inverted-U effect reflects the transition from technological adoption to institutional adaptation, which is a critical stage for emerging economies. Despite the positive impact of digitalization and structural changes, the results of the study reveal a number of limitations characteristic of Kazakhstan's industrial development. Firstly, there remains a high dependence on the extractive sector, which reduces the overall level of technological intensity of the economy. Even with the growing share of the manufacturing industry, its contribution to TFP remains limited.

Secondly, there is an asymmetry in regional development, which is reflected in differences in the level of digitalization and production efficiency. This indicates the need for a differentiated regional policy. Thirdly, the institutional environment remains insufficiently adapted to digital transformation. Limited competition, weak integration of science and business, as well as insufficient development of innovation infrastructure reduce the effectiveness of technological investments.

The results obtained are important for the formation of an economic policy aimed at modernizing the industrial sector of Kazakhstan.

First, it is necessary to move from quantitative investment growth to stimulating its effectiveness. This involves the development of return-on-investment assessment mechanisms, including the introduction of TFP-oriented KPIs.

Secondly, digitalization should be considered not as an isolated process of technology introduction, but as a complex transformation, including:

- development of human capital (digital skills, STEM education),
- Institutional reforms,
- Support for innovative entrepreneurship.

Thirdly, given the inverted-U effect identified, digitalization policy should be

differentiated. In the early stages, the emphasis should be on mass adoption of basic technologies, while in the more mature stages it should be on increasing the efficiency of their use.

Fourthly, it is necessary to strengthen the structural policy aimed at the development of the manufacturing industry. This includes:

- Stimulating export-oriented industries,
- Cluster development,
- Support for high-tech industries.

Finally, it is necessary to take into account regional differences, forming an adaptive industrial policy focused on local advantages and the level of infrastructure development.

Thus, the results of the study confirm the key provisions of the theory of endogenous growth and international empirical literature, while identifying the specific features of the transformation of the industrial sector in Kazakhstan. The central conclusion is that digitalization is the main driver of productivity growth, but its effect is non-linear and depends on the institutional environment.

This means that the further development of Kazakhstan's industry will be determined not so much by the scale of investments as by the economy's ability to effectively integrate technology, knowledge and innovation into production processes.

Conclusion. The present study was aimed at a comprehensive analysis of the transformation of the industrial sector of the Republic of Kazakhstan in 2000-2025 with an emphasis on the assessment of aggregate factor productivity (TFP), the role of digitalization and structural changes. The use of growth decomposition methods, panel econometric analysis and a comparative approach made it possible to identify key patterns and mechanisms of industrial development in the context of the transition to the digital economy.

The results of the study show that Kazakhstan's industrial growth in the long term is characterized by a gradual transition from an extensive model based on capital accumulation to a more intensive model focused on increasing efficiency. Despite the continued importance of investments, their relative contribution to growth is decreasing, while the role of aggregate factor productivity is increasing.

Of particular importance is the revealed positive relationship between digitalization and TFP. Econometric analysis has confirmed that digital technologies are a key driver of productivity growth, providing a significant contribution to the efficiency of industrial production. At the same time, it was found that the impact of digitalization is nonlinear: at a certain stage, the effect of diminishing returns occurs, reflecting the need for institutional and organizational adaptation to new technologies.

Additionally, it has been established that the structural transformation of industry, expressed in an increase in the share of the manufacturing sector, has a significant positive impact on productivity. This confirms the hypothesis that economic diversification is an essential condition for sustainable development.

From a scientific point of view, this study contributes to the development of the theory of endogenous growth in relation to emerging economies. In particular:

- the key role of digitalization as a factor of endogenous productivity growth has been empirically confirmed;
- the nonlinear (inverted-U) effect of digitalization has been identified and quantified, which expands existing ideas about the limits of the effectiveness of technological development;

The relationship between the structural diversification of industry and the dynamics of TFP is substantiated, which complements the theoretical models of structural transformation.

Thus, the study demonstrates that in conditions of catch-up development, digitalization not only accelerates growth, but also changes the very nature of economic dynamics.

The results obtained have important applied implications for the formation of industrial and innovation policy in Kazakhstan.

First, it is necessary to shift the focus from quantitative growth of investments to increasing their efficiency. This involves the development of mechanisms for evaluating the effectiveness of investments through performance indicators and TFP.

Secondly, digitalization should be considered as a systemic process that includes not only the introduction of technology, but also the development of human capital, institutional mechanisms and an innovation ecosystem. Without these elements, the effect of digital investments will be limited.

Thirdly, taking into account the revealed nonlinear effect of digitalization, government policy should be differentiated by stages of development. In the early stages, it is necessary to stimulate the widespread adoption of technologies, while in the more mature stages it is necessary to increase the efficiency of their use and integration into business processes.

Fourth, special attention should be paid to the development of the manufacturing industry as a key source of productivity growth. This requires the support of high-tech industries, the development of cluster initiatives and the promotion of export orientation.

Finally, an important focus is to reduce regional disparities by developing adaptive policies that take into account differences in the level of digitalization, infrastructure, and human capital.

Despite the significant results obtained, the study has a number of limitations. In particular, the aggregated data used does not allow for full consideration of intra-industry heterogeneity and micro-level effects. In addition, the influence of institutional factors was taken into account indirectly.

In this regard, promising areas for further research are:

- the use of micro-level enterprise data for a more accurate assessment of the impact of digitalization;

- Application of Stochastic Frontier (SFA) and DEA methods for performance analysis;
- research on the role of human capital and innovative ecosystems in shaping TFP;
- Comparative analysis with other emerging economies.

Thus, the transformation of Kazakhstan's industrial sector is determined by the transition to a growth model based on knowledge, technology and resource efficiency. The central factor in this process is digitalization, which, if there are appropriate institutional conditions, can ensure sustainable growth in productivity and competitiveness of the economy.

At the same time, further progress depends on the ability of the state and business to move from the simple introduction of technologies to their effective integration into the economic system, which requires comprehensive structural and institutional transformations.

References

- Aiginger K., and Rodrik D. (2020) Rebirth of industrial policy and an agenda for the twenty-first century. *Journal of Industry, Competition and Trade*, 20. — P. 189–207. <https://doi.org/10.1007/s10842-019-00322-3> (in Eng.)
- Beck T., Demirgüç-Kunt A., and Levine R. (2005) SMEs, growth, and poverty: Cross-country evidence. *Journal of Economic Growth*, 10(3). — P. 199–229. <https://doi.org/10.1007/s10887-005-3533-5> (in Eng.)
- Brynjolfsson E., and McAfee A. (2014) *The second machine age: Work, progress, and prosperity in a time of brilliant technologies*. W. W. Norton and Company. (in Eng.)
- EBRD (2024) *Transition report 2024–2025: Kazakhstan country assessment*. European Bank for Reconstruction and Development. (in Eng.)
- Fujita M., Krugman P., and Venables A.J. (1999) *The spatial economy: Cities, regions, and international trade*. MIT Press. (in Eng.)
- Hausmann R., Hidalgo C.A., Bustos S., Coscia M., Simoes A., and Yildirim M.A. (2014) *The atlas of economic complexity: Mapping paths to prosperity*. MIT Press. (in Eng.)
- Kulkayeva G. (2023) *Promyshlennoe razvitiye v Kazahstane [Industrial development in Kazakhstan]*. *Economics and statistics*, (2). — P. 45–58. (in Russian)
- Lin J.Y. (2012) *New structural economics: A framework for rethinking development and policy*. World Bank. <https://doi.org/10.1596/978-0-8213-8955-3> (in Eng.)
- McMillan M., Rodrik D., and Sepúlveda C. (2017) *Structural change, fundamentals, and growth: A framework and case studies*. International Food Policy Research Institute. (in Eng.)
- OECD (2022) *SME and entrepreneurship policy in Kazakhstan*. OECD Publishing. (in Eng.)
- OECD (2023) *Economic policy reforms 2023: Going for growth*. OECD Publishing. <https://doi.org/10.1787/9953de23-en> (in Eng.)
- Rodrik D. (2016) *Premature deindustrialization*. *Journal of Economic Growth*, 21(1). — P. 1–33. <https://doi.org/10.1007/s10887-015-9122-3> (in Eng.)
- Schwab K. (2016) *The fourth industrial revolution*. World Economic Forum. (in Eng.)
- Shayakhmetova K., Abdikarimova M., and Tulegenova A. (2021) *Promyshlennyye reformy v Kazahstane [Industrial reforms in Kazakhstan]*. *Vestnik KazNU*. (in Russian)
- UNIDO (2020) *Industrial development report 2020: Industrializing in the digital age*. United Nations Industrial Development Organization. (in Eng.)
- UNIDO (2022) *Industrial development report 2022: The future of industrialization in a post-pandemic world*. United Nations Industrial Development Organization. (in Eng.)

- World Bank (2025) Kazakhstan economic update, winter 2024–2025. World Bank. (in Eng.)
- Zamanbekov S., et al. (2020) Regional development of small and midsize businesses in Kazakhstan. *Entrepreneurship and Sustainability Issues*, 8(1). — P. 618–639. (in Eng.)
- Zarubina V., et al. (2024) Sustainable development of small business in Kazakhstan. *Economics*, 12(9). — 247. <https://doi.org/10.3390/economics12090247> (in Eng.)
- Zhumagulov A., et al. (2022) Finansirovanie promyshlennosti v Kazahstane [Financing of industry in Kazakhstan]. *Bulletin of Economics*, (4). — P. 33–41. (in Russian)

Publication Ethics and Publication Malpractice in the journals of the Central Asian Academic Research Center LLP

For information on Ethics in publishing and Ethical guidelines for journal publication see <http://www.elsevier.com/publishingethics> and <http://www.elsevier.com/journal-authors/ethics>.

Submission of an article to the journals of the Central Asian Academic Research Center LLP implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see <http://www.elsevier.com/postingpolicy>), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The Central Asian Academic Research Center LLP follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics.org/files/u2/New_Code.pdf). To verify originality, your article may be checked by the Cross Check originality detection service <http://www.elsevier.com/editors/plagdetect>.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/ or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the Central Asian Academic Research Center LLP.

The Editorial Board of the Central Asian Academic Research Center LLP will monitor and safeguard publishing ethics.

Requirements for articles design for publication in the journal are available on the websites:

[www: nauka-nanrk.kz](http://www.nauka-nanrk.kz)

ISSN 2518–1467 (Online),

ISSN 1991–3494 (Print)

<http://www.bulletin-science.kz/index.php/en>

Managing Editor: A.Shormakova

Editors: D.S. Alenov, M.Konyrbekov

Computer layout: G.D. Zhadyranova

Подписано в печать 27.04.2026.

46,0 п.л.

Заказ 2.