IRSTI 06.73 https://doi.org/10.26577/be202515441

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R&D EXPENDITURES AS A DRIVER OF INVESTMENT AND ECONOMIC GROWTH IN KAZAKHSTAN

This article examines the impact of R&D expenditures on capital investment and economic growth in Kazakhstan. R&D spending plays a crucial role in the development of new technologies, the improvement of existing products and processes, and stimulates the advancement of science and human capital. Moreover, active R&D financing is often accompanied by investments in fixed capital, which suggests a potential relationship between the two types of investment. The study aims to assess how R&D expenditures influence capital investment and GDP growth, taking into account potential time-lag effects. The methodological framework of the study is based on a vector autoregression (VAR) model estimated in first differences, which makes it possible to analyze short-term dynamics and lagged effects in the relationships between R&D expenditures, fixed capital investment, and economic growth. The stationarity of the time series was tested using the augmented Dickey–Fuller (ADF) test, while the direction of causal relationships was assessed using Granger causality tests. The results of the VAR model show that changes in R&D expenditures, although they do not have a statistically significant direct effect on changes in capital investment, have a positive impact on changes in GDP growth rates with a one-period lag. In turn, Granger causality tests confirm a unidirectional causal relationship running from changes in GDP growth rates to changes in R&D expenditures. Overall, the results highlight the complexity and time-lag dependence of the interaction between innovation, investment, and growth in Kazakhstan. The theoretical significance of the study lies in refining the mechanisms through which innovation activity exerts short-term effects on economic growth in the context of a developing economy, as well as in identifying the lag-dependent nature of interactions between intangible and tangible investments. The practical significance of the study consists in the possibility of using the obtained results in the formulation of public policy in the areas of innovation development and investment promotion, particularly in the design of R&D support measures that take into account time lags and macroeconomic conditions. The value of the obtained results lies in providing new empirical evidence on the nature of the relationships between R&D expenditures, investment, and economic growth in Kazakhstan, thereby expanding the empirical base of research on innovation-driven growth in emerging economies.

Keywords: R&D expenditures, capital investment, economic growth, VAR model.

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Қазақстандағы инвестициялар мен экономикалық өсудің қозғаушы күші ретіндегі ҒЗТКЖ шығындары

Мақалада ҒЗТКЖ-ға жұмсалатын шығындар және олардың негізгі капиталға салынатын инвестициялар мен Қазақстанның экономикалық өсуіне әсері талданады. ҒЗТКЖ шығындары жаңа технологияларды дамытуда, қолданыстағы өнімдер мен үдерістерді жетілдіруде, ғылым мен адами капиталдың дамуын ынталандыруда шешуші рөл атқарады. Сонымен қатар, ҒЗТКЖ-ны белсенді қаржыландыру негізгі капиталға салынатын инвестициялармен қатар жүреді. Бұл екі инвестиция түрінің арасында өзара байланыс бар екенін көрсетеді. Зерттеудің мақсаты – уақытша лагтың ықтимал әсерлерін ескере отырып, ҒЗТКЖ-ға жұмсалатын шығындардың капитал салымдарына және ЖІӨ-нің өсуіне қалай әсер ететінін бағалау. Зерттеудің әдіснамалық негізі алғашқы айырмаларда бағаланған векторлық авторегрессиялық модель (VAR), бұл ҒЗТКЖ-ға жұмсалатын шығындар, негізгі капиталға салынатын инвестициялар және экономикалық өсу арасындағы өзара байланыстардың қысқа мерзімді динамикасы мен уақыттық лагтық әсерлерін талдауға мүмкіндік береді. Уақыттық қатарлардың стационарлығы кеңейтілген Дики–Фуллер (ADF) тесті арқылы тексерілді, ал себеп-салдарлық байланыстардың бағыты Грейнджер себептілік тесттері көмегімен бағаланды. VAR моделінің нәтижелері ҒЗТКЖ-ға жұмсалатын шығындардағы өзгерістер капитал салымдарындағы өзгерістерге статистикалық тұрғыдан маңызды тікелей әсер

етпегенімен, ЖІӨ өсу қарқынындағы өзгерістерге бір кезеңдік лагпен оң әсер ететінін көрсетеді. Грейнджердің себептілік тесттері ЖІӨ өсу қарқынындағы өзгерістерден ҒЗТКЖ-ға жұмсалатын шығындардағы өзгерістерге қарай бағытталған біржақты себеп-салдарлық байланысты растайды. Зерттеу нәтижелері Қазақстандағы инновациялар, инвестициялар және экономикалық өсім арасындағы өзара әрекеттесудің күрделілігі мен уақытша лагқа тәуелділікті көрсетеді. Зерттеудің теориялық маңыздылығы дамушы экономика жағдайында инновациялық белсенділіктің экономикалық өсуге қысқа мерзімді ықпал ету тетіктерін нақтылауда, сондай-ақ материалдық емес және материалдық инвестициялар арасындағы өзара әрекеттестіктің уақыттық лагтарға тәуелді сипатын айқындауда көрініс табады. Жұмыстың практикалық маңыздылығы алынған нәтижелерді инновациялық даму және инвестицияларды ынталандыру саласындағы мемлекеттік саясатты қалыптастыру барысында, атап айтқанда уақыттық лагтар мен макроэкономикалық конъюнктураны ескере отырып ҒЗТКЖ-ды қолдау шараларын әзірлеуде пайдалану мүмкіндігімен айқындалады. Алынған нәтижелердің құндылығы Қазақстандағы ҒЗТКЖ, инвестициялар және экономикалық өсу арасындағы өзара байланыстардың сипаты жөнінде жаңа эмпирикалық дәлелдер ұсынылуында, бұл қалыптасушы экономикасы бар елдердегі инновацияға негізделген экономикалық өсуді зерттеудің эмпирикалық базасын кеңейтеді.

Түйін сөздер: ҒЗТКЖ шығындары, негізгі капиталға салынатын инвестициялар, экономикалық өсу, VAR моделі.

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Расходы на НИОКР как драйвер инвестиций и экономического роста Казахстана

В статье анализируются затраты на НИОКР и их взаимосвязь с инвестициями в основной капитал и экономическим ростом Казахстана. Расходы на НИОКР играют решающую роль в развитии новых технологий, улучшении существующих продуктов и процессов, стимулируют развитие науки и человеческого капитала. Кроме того, активное финансирование НИОКР сопровождается вложениями в основной капитал, что предполагает существование взаимосвязи между двумя типами инвестиций.

Цель исследования – оценить, как расходы на НИОКР влияют на капиталовложения и рост ВВП с учетом потенциальных эффектов временного лага. Методологической основой исследования является векторная авторегрессионная модель (VAR), оцененная в первых разностях, что позволяет проанализировать краткосрочную динамику и лаговые эффекты взаимосвязей между расходами на НИОКР, инвестициями в основной капитал и экономическим ростом. Стационарность временных рядов проверялась с использованием расширенного теста Дики–Фуллера (ADF), а направленность причинно-следственных связей оценивалась с помощью тестов причинности Грейнджера. Результаты VAR-модели показывают, что изменения в расходах на НИОКР хотя и не оказывают статистически значимого прямого влияния на изменения в капитальных вложениях, они положительно влияют на изменения темпов роста ВВП с одноперiодным лагом. В свою очередь, тесты причинности Грейнджера подтверждают одностороннюю причинно-следственную связь от изменений темпов роста ВВП к изменениям в расходах на НИОКР. В целом результаты подчеркивают сложность и зависимость от временного лага взаимодействия между инновациями, инвестициями и ростом в Казахстане. Теоретическая значимость исследования заключается в уточнении механизмов краткосрочного воздействия инновационной активности на экономический рост в условиях развивающейся экономики, а также в выявлении лагозависимого характера взаимодействия между нематериальными и материальными инвестициями. Практическая значимость работы состоит в возможности использования полученных результатов при формировании государственной политики в сфере инновационного развития и инвестиционного стимулирования, в частности при разработке мер поддержки НИОКР с учетом временных лагов и макроэкономической конъюнктуры. Ценность полученных результатов заключается в предоставлении новых эмпирических свидетельств о характере взаимосвязей между НИОКР, инвестициями и экономическим ростом в Казахстане, что расширяет эмпирическую базу исследований инновационно-ориентированного роста в странах с формирующейся экономикой.

Ключевые слова: затраты на НИОКР, инвестиции в основной капитал, экономический рост, VAR-модель.

Introduction

In modern conditions of increasing competition in international markets and intensive development and implementation of advanced innovative technologies in world markets, Kazakhstan faces an urgent need to develop a new approach to managing the national economy. The strategic goal of the Republic of Kazakhstan is the need to achieve high-quality and sustainable economic growth leading to an increase in people's living standards based on strengthening business competitiveness, technological modernization, improving the institutional environment and minimizing negative impacts on nature, which is consistent with the UN Sustainable Development Goals. In this regard, the domestic economy remains in constant need of investment resources necessary for the development of the real sector. Particular emphasis should be placed on building sustainable infrastructure to foster industrialization and innovation through increased R&D spending.

The Concept for the Development of Higher Education and Science in the Republic of Kazakhstan for 2023-2029 notes the need for a phased increase in R&D costs from all sources to 1% of GDP. This measure aims to enhance is the global competitiveness of Kazakh science and its contribution to solving national-level applied challenges. It should be borne in mind that according to international standard definitions adopted in the economy of the Republic of Kazakhstan, domestic R&D expenditures are synonymous with R&D results (MSHE RK, 2022).

An analysis of internal R&D costs in terms of funding sources shows that the state remains the main investor in scientific research. It accounts for more than 60% of the costs. The share of own funds, which can be considered as investments of entrepreneurs, decreases annually (Akorda, 2024). The demand for R&D remains at a very low level due to the fact that it is not being brought to a state where this knowledge can be used in economic activities and in production. Less than 15% is invested in research and development aimed at creating new materials, products, processes, devices, services, systems or methods and their further improvement.

As you know, Kazakhstan ranks 78th in the Report on the Global Innovation Index for 2024, having demonstrated good results in the field of online government services, utility models and e-participation. However, in terms of investment in R&D, the result deteriorated by 5.1% compared to 2022 (WIPO, 2024). Despite the increase in R&D costs, the science intensity of GDP has not changed in recent years, remaining at the level of 0.12–0.14%. Consequently, the expansion of investment support for R&D and innovation is one of the key problems in Kazakhstan, which underlines the relevance of the topic of this study.

This study examines the impact of R&D investment on two key areas: first, on capital investment; and second, on the economic growth of Kazakhstan. On the one hand, R&D investments can directly influence economic growth through the introduction of new technologies, increased productivity, innovation, and so on. Therefore, R&D investment can be considered a driver of economic growth. On the other hand, R&D investments are often made alongside capital investments, as companies that actively invest in new technologies and products also tend to invest in equipment, production facilities, and other fixed assets. This suggests that R&D investment may influence the dynamics of capital investment. In this regard, it is appropriate to examine the relationship between R&D investment and capital investment, as well as between R&D investment and economic growth.

Literature review

The study of the problems of investment and its effective use has always been in the focus of economic science, since it is investments that affect the deepest foundations of economic activity, determining the pace of economic growth of a country. Therefore, investment policy deserves special attention in economic policy, which is a crucial component in the process of managing the country's economy.

A deeper theoretical understanding of the R&D–growth nexus is provided by endogenous growth theory, which explicitly models technological progress as the outcome of purposeful investment in knowledge. In Romer's seminal model (1990), R&D expenditure increases the stock of ideas, which are characterized by non-rivalry and increasing returns. As firms invest in research, they enhance the productivity of both labor and capital, generating sustained economic growth. In this framework, R&D not only stimulates innovation but also raises the marginal productivity of private investment.

A complementary perspective is offered by the Schumpeterian model of (Aghion & Howitt, 1992), where economic growth arises through "creative destruction". Firms engage in R&D to produce better-quality technologies that replace outdated ones, and

this process drives long-term productivity improvements. In such models, the incentives to invest in research depend critically on expected returns, market structure, and institutional quality. Thus higher innovation effort increases the frequency of technological upgrading, enhances competitiveness, and fuels broader investment flows.

Research on R&D at the national and regional levels mainly focuses on its economic effectiveness. However, the issue of the driving forces of innovation is ignored. Works by Jaffe (1989), Bottazzi & Peri (2003), Crescenzi et al. (2007), Wang et al. (2016), Rodriguez-Pose (1999) and Bilbao-Osorio & Rodriguez-Pose (2004) demonstrate that investments in R&D stimulate both the generation of new knowledge and economic growth. At the same time, territorial specifics play a key role. Researchers Ginevicius R. (2023), Arana Barbier (2023), Mudronja et al (2019), Wynn et al. (2022) have deepened the study of the role of investment in R&D in the economic development of individual regions and industries. (Wang et al., 2016) have shown the strong impact of economic infrastructure development on the quality of innovation in China's provinces. In addition, localized and interregional knowledge spillovers constitute a key mechanism through which R&D activity affects productivity and economic growth (Jaffe, 1989; Bottazzi and Peri, 2003), (Crescenzi et al., 2007) found significant differences in the reasons for patenting between the United States and Europe, which underscores the importance of taking into account territorial features when studying innovation processes.

Huseynli's article (2023) examines the impact of investment in R&D on accelerating economic growth in several countries in the Central Asian region. Kazakhstani authors (Nurmaganbetov& Tugushev, 2024). In their research, they analyze the current state and prospects of investment in research and development (R&D) in Kazakhstan's high-tech sectors, as well as consider barriers hindering investment growth. (Seitkan et al., 2024) assessed the impact of R&D costs on various aspects of innovation activity in Kazakhstan, such as the share of innovative products in GDP and the cost of product and process innovations. The results confirm the importance of R&D investments for economic growth.

A closer examination of Kazakhstan's national innovation system reveals institutional features that significantly shape the effectiveness of R&D investment. (Sadyrova et al., 2021) note that innovation processes in Kazakhstan are constrained by weak linkages between science and industry, limited private-sector demand for innovation, and underdeveloped commercialization mechanisms. Despite increasing state support, these structural issues reduce the transformative impact of R&D expenditures.

According to Baxultanov et al. (2022), Kazakhstan's R&D landscape is characterized by low research intensity, the predominance of public funding, and an uneven distribution of scientific resources. The authors emphasize that fragmented innovation infrastructure and inefficient resource allocation hinder the conversion of R&D inputs into measurable innovation outputs.

The broader institutional trajectory is also important. (Danabayeva & Shedenov, 2015) argue that Kazakhstan's transition toward a knowledge-based economy requires not only greater investment in science but also deeper institutional reforms to strengthen coordination among government, business, and academia. Their work highlights limited technological absorption capacity within firms as a persistent barrier.

More recent studies underline the relevance of the innovation ecosystem approach. (Nauryzbaeva et al., 2024) show that although Kazakhstan has expanded its innovation support structures– technology parks, accelerators, grant programs– the regulatory environment remains inconsistent, and coordination between ecosystem actors is weak. Earlier research by (Kusmoldaeva & Khudaybergenova, 2017) similarly stresses that the innovation system is heavily state-driven, while market-based mechanisms and private R&D investment remain underdeveloped.

Taken together, these studies indicate that while the institutional context of R&D in Kazakhstan has been examined from various angles, the literature predominantly focuses on descriptive assessments of innovation capacity, structural barriers, and policy frameworks. What remains less explored is how these institutional characteristics translate into measurable macroeconomic outcomes. In particular, despite the recognized importance of R&D for innovation and growth, few studies investigate the quantitative relationship between R&D expenditures, capital formation, and economic growth using econometric approaches.

At the empirical level, identifying the causal impact of R&D expenditures on investment and economic growth is challenging due to several sources of endogeneity. First, reverse causality is likely,

so faster economic growth and higher investment capacity may themselves lead to increased R&D spending. Second, omitted variables (institutional quality, human capital or macroeconomic stability) may simultaneously affect R&D intensity and growth outcomes, biasing simple estimations. Third, R&D investments often exhibit delayed effects implying dynamic adjustment processes rather than instantaneous impacts.

To address these issues, the empirical literature has employed a range of time-series and panel econometric strategies. Multivariate time-series approaches, such as Vector Error Correction Models (VECM) and Structural VAR (SVAR), are commonly employed to model feedback effects and long-run equilibrium relationships among R&D, investment, and output (Ercan Merve, 2025). Cross-country and panel studies frequently rely on instrumental variable techniques to address simultaneity and omitted variable bias. More recently, Autoregressive Distributed Lag (ARDL) models have gained prominence, particularly in studies focusing on single-country analyses or small samples, as they allow for mixed orders of integration, explicitly model short- and long-run dynamics, and partially alleviate endogeneity by incorporating lag structures (Xuan, 2025; Simut Ramona et al., 2003).

Despite these methodological advances, relatively few studies apply such econometric frameworks to resource-rich, transition economies like Kazakhstan, where the structure of R&D financing is heavily state-driven and private-sector innovation remains limited. This raises an additional identification concern. The effectiveness of R&D expenditures may depend not only on their volume but also on institutional complementarities and the investment climate. Consequently, the estimated impact of R&D on growth may differ substantially from that observed in advanced economies.

Against this background, the present study contributes to the literature by empirically examining the dynamic relationship between R&D expenditures, capital investment, and economic growth in Kazakhstan within an endogenous growth perspective. By employing a time-series framework that distinguishes between short- and long-run effects, the analysis explicitly accounts for feedback mechanisms and mitigates endogeneity concerns inherent in the R&D-growth nexus. This approach allows for a more nuanced assessment of whether R&D acts primarily as a direct engine of growth, an indirect driver through capital accumulation, or both.

The present study proposes a two-level empirical analysis assessing the relationship between R&D expenditures, capital investment and economic growth in Kazakhstan. Accordingly, the following hypotheses are formulated:

H1: There is a relationship between R&D investment and investment in fixed capital;

H2: R&D investment has a positive effect on Kazakhstan's economic growth.

Methodology

The study employed the following variables: economic growth (real GDP volume index by production method, % compared to the previous year), investment in fixed assets (in comparable prices of 2000, billion tenge) and R&D expenditures (in comparable prices of 2000, billion tenge). Control variable – share of the working-age population (as a percentage of the total population). The study used annual data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan for the period 2000–2024.

Figure 1 shows the dynamics of the indicators used to build the econometric model, according to the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan.

Figure 1 presents annual data for Kazakhstan over the period 2000–2024, including economic growth, investment in fixed assets, R&D expenditures, and the share of the working-age population. Economic growth exhibits pronounced cyclical fluctuations, ranging from rapid expansion in the early 2000s to a contraction in 2020, reflecting major external and domestic shocks. Investment in fixed assets, measured in constant 2000 prices, shows a long-term upward trend with notable volatility, particularly during periods of economic instability. R&D expenditures, also expressed in constant prices, increase gradually over the sample period but remain relatively modest in scale, indicating limited research intensity despite recent acceleration after 2022. The share of the working-age population follows a declining trajectory after the mid-2010s, suggesting emerging demographic constraints. Overall, the table highlights substantial variation across macroeconomic and innovation-related indicators, providing a suitable basis for analyzing the dynamic relationship between R&D activity, investment behavior, and economic growth in Kazakhstan.

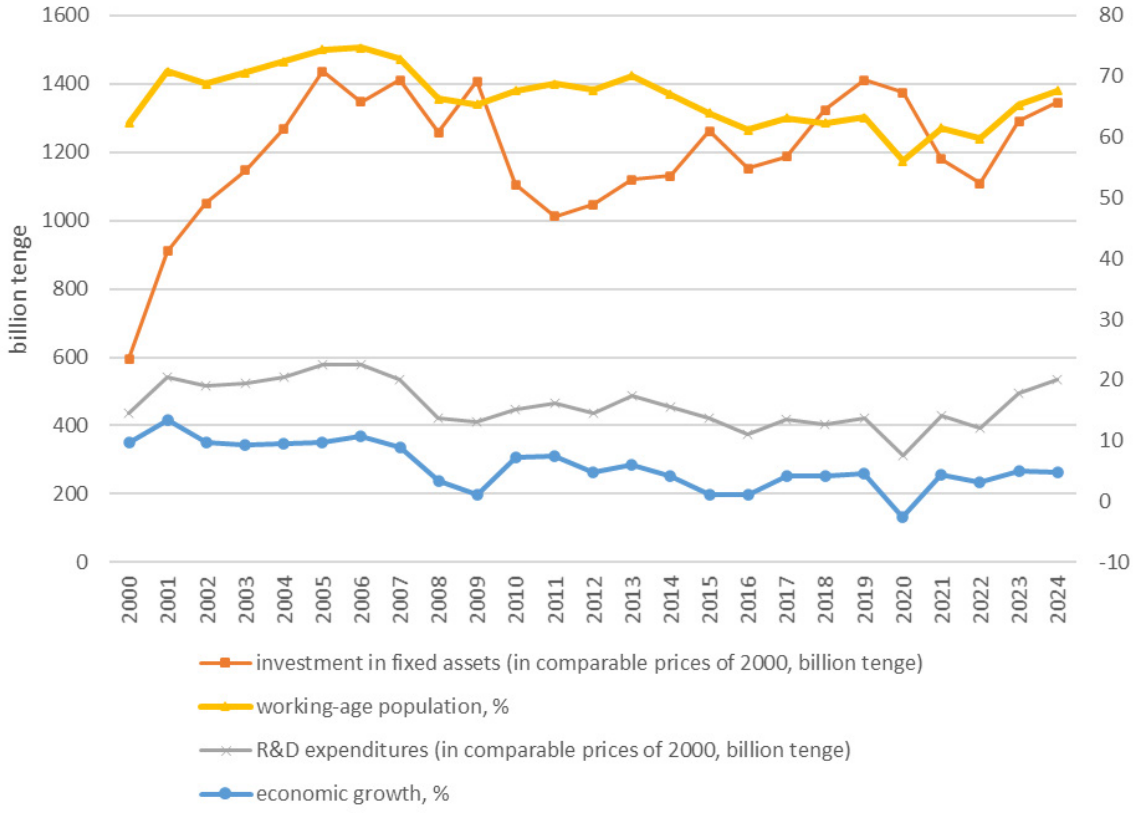

Figure 1 – Economic growth, R&D expenditures and capital investment in Kazakhstan
Note – compiled by the authors

In our study, the assessment of the relationship between variables was carried out using the construction of a VAR model, OLS, ADF test, and Granger causality test, implemented with Python in the Google Colab environment. The VAR system is estimated equation-by-equation using OLS, which is standard under the assumption of identical regressors across equations

The selection of the VAR model is based on the dynamic nature of the relationship between R&D expenditures, capital investment, and economic growth. VAR is suitable when variables may influence each other over time and when the objective is to capture short-run interactions without imposing restrictive structural assumptions.

Before estimating the model, we performed unit-root testing using the Augmented Dickey–Fuller (ADF) test. The results showed that some variables are non-stationary in levels but become stationary after first differencing. Since all transformed series are stationary and no cointegration relationship was detected, the use of a Vector Error Correction Model (VECM) is not justified. Likewise, the ARDL approach is typically applied when the goal is to estimate long-run cointegration relationships between I(0) and I(1) variables, which is not the aim of the present study.

Given the absence of cointegration and the study's focus on short-term dynamic effects, the VAR model represents the most appropriate methodological choice. The optimal lag length was selected using standard information criteria (AIC, BIC, FPE, HQIC), which consistently indicated the need to include several lags. This provides a statistically grounded basis for examining how changes in R&D expenditures propagate through investment and growth channels.

At the first stage of the study, the relationship between investment in fixed capital and R&D expenditures was assessed. These indicators may influence each other with a certain time lag. Therefore, the time lag effect was incorporated into the model specification.

At the second stage of the study, the relationship between R&D expenditures and economic growth was examined.

Results and discussion

The use of the VAR (Vector Autoregression) model requires that the time series be stationary, that is, their statistical properties do not change over time. Stationarity testing of the time series was conducted using the Augmented Dickey-Fuller (ADF) test. To transform the non-stationary time series into stationary ones, differencing was applied. Stationarity was achieved after the first differencing.

Since the time series exhibit a mixed order of integration, the VAR model was estimated in first differences to ensure stationarity of all variables. This approach avoids spurious regression and satisfies the statistical requirements of the VAR framework. While differencing eliminates potential long-run equilibrium relationships, it enables a consistent examination of short-run dynamic interactions between changes in R&D expenditures, investment and economic growth. Thus, in our case, the use of VAR in first differences focuses on the short-run effects of changes in R&D, investment, and economic growth.

The results of the stationarity test are presented in Table 1.

Table 1 – Results of the time series stationarity test

	ADF Statistic	p-value	Critical values		
			1%	5%	10%
Δ Investments in fixed assets	-4.086078	0.001021	-4.012034	-3.104184	-2.690987
Δ R&D expenditures	-4.299762	0.000445	-3.752928	-2.998500	-2.638967
Δ Economic growth	-6.381253	2.219486e-08	-3.752928	-2.9985	-2.638967
Δ Share of the working-age population (first differentiation)	-5.468752	2.425335e-06	-3.752928	-2.9985	-2.638967
Note – Calculated by the authors					

The ADF statistics for the analyzed data were below the critical value at the 1% significance level, indicating stationarity of the time series. The p-value confirmed that the null hypothesis of the presence of a unit root was rejected.

After data transformation and stationarity testing, it was necessary to determine the optimal number of lags to include in the model. The lag selection was performed using the AIC, BIC, FPE, and HQIC criteria based on the construction of a Vector Autoregression (VAR) model. These criteria helped select the optimal number of lags (Table 2).

The table shows that the minimum is reached at lag 4 (AIC = -0.01249). This means that to capture the dynamics of changes in the data, it is necessary to account for 4 periods back. Since differencing removes the trend, the selected lags reflect the period over which past changes in the variables influence current changes. In other words, changes in R&D expenditures, investments, and economic growth from 4 years ago have an impact on the current changes in the respective variable.

From an economic perspective, the effects of investment in fixed capital and R&D expenditures are expected to materialize within a relatively short horizon. For annual data, a lag length of 1 to 4 years captures the medium-term adjustment process related to investment planning, implementation, and innovation diffusion, while longer lags are difficult to interpret economically.

At the first stage, the causal relationship between R&D expenditures and investment in fixed assets was analyzed. The modeling results are presented in the tables 3-5.

The model results indicate that changes in fixed capital investment are primarily driven by their own past changes, particularly with a three-period lag. In contrast, changes in R&D expenditures do not have a statistically significant impact on the current changes in fixed capital investment.

Table 2 – AIC, BIC, FPE and HQIC values for determining the optimal number of lags (* – optimal lag)

Lags	AIC	BIC	FPE	HQIC
Lag 0	2.369	2.519	10.69	2.399
Lag 1	2.447	3.044	11.74	2.563
Lag 2	2.621	3.666	15.08	2.825
Lag 3	1.018	2.512	3.722	1.310
Lag 4	-0.01249*	1.929*	2.094*	0.3665*
Note – Calculated by the authors				

Table 3 – Characteristics of the VAR model

Model:	VAR	Log Likelihood	-148.229
Method:	OLS	AIC	10.9471
Date:	Tue, 08, Jul, 2025	BIC	11.8433
Time:	12:58:29	HQIC:	11.1221
No. of Equations:	2.00000	FPE:	65245.7
Nobs:	20.0000	Det(Omega_mle):	31032.5
		Correlation	0.668420
Note – Calculated by the authors based on the VAR model			

Table 4 – Results of the VAR model for investments in fixed capital

	coef	std err	t-stat	prob
const	-1.304465	32.905869	-0.040	0.968
L1. Δ Investment	-0.096889	0.384460	-0.252	0.801
L1. Δ R&D	-6.750701	31.461402	-0.215	0.830
L2. Δ Investment	0.219680	0.388023	0.566	0.571
L2. Δ R&D	-34.186676	34.842102	-0.981	0.326
L3. Δ Investment	-0.774445	0.395484	-1.958	0.050
L3. Δ R&D	50.744009	32.559880	1.558	0.119
L4. Δ Investment	0.033502	0.426858	0.078	0.937
L4. Δ R&D	28.168025	35.165001	0.801	0.423
Note – Calculated by the authors based on the VAR model				

Table 5 – Results of the VAR model for R&D expenditures

	coef	std err	t-stat	prob
const	0.122628	0.416293	0.295	0.768
L1. Δ Investment	-0.004466	0.004864	-0.918	0.358
L1. Δ R&D	0.239315	0.398019	0.601	0.548
L2. Δ Investment	0.002183	0.004909	0.445	0.657
L2. Δ R&D	-0.437388	0.440788	-0.992	0.321
L3. Δ Investment	-0.012475	0.005003	-2.493	0.013
L3. Δ R&D	0.629078	0.411916	1.527	0.127
L4. Δ Investment	0.004250	0.005400	0.787	0.431
L4. Δ R&D	-0.005823	0.444873	-0.013	0.990
Note – Calculated by the authors based on the VAR model				

The VAR model results for R&D investment indicate that past changes in fixed capital investment at lag 3 have a statistically significant negative effect on current changes in R&D expenditures (p = 0.013). Other lags do not show statistically significant effects.

The correlation between the residuals of the two equations is 0.668, suggesting a moderate positive relationship between the unexplained components of the two models. Overall, the results point to a one-way, lagged effect of changes in fixed capital investment on changes in R&D expenditures, while no reverse effect is observed.

Subsequently, the causal relationship between changes in R&D expenditures and changes in fixed capital investment was examined using Granger causality tests, which assess the predictive influence of one variable's past changes on another. The results of the Granger tests are presented in Tables 6–7.

Table 6 – Granger test values (the impact of R&D expenditures on fixed capital investment)

Lags	F	p	chi2	p	df
Lag 1	0.1557	0.6973	0.1791	0.6721	1
Lag 2	0.0123	0.9877	0.0319	0.9842	2
Lag 3	0.5588	0.6509	2.5145	0.4727	3
Lag 4	1.0690	0.4172	7.7747	0.1002	4
Note – Calculated by the authors					

The Granger causality test, applied to the first-differenced (stationary) series, revealed no statistically significant causal relationship from changes in R&D expenditures to changes in fixed capital investment for any of the lags considered (from 1 to 4). In all cases, the p-values for the main statistical indicators (the F-test, the chi-square test, and the likelihood ratio test) were substantially above the 0.05 significance level. This indicates that there is no evidence to support hypothesis H1, which posits a relationship between R&D investment and fixed capital investment. Past changes in R&D expenditures do not significantly influence current changes in fixed capital investment.

Table 7 – Granger test values (the impact of fixed capital investment on R&D expenditures)

Lags	F	p	chi2	p	df
Lag 1	0.1789	0.6769	0.2057	0.6502	1
Lag 2	0.4249	0.6606	1.0998	0.5770	2
Lag 3	1.3049	0.3119	5.8721	0.1180	3
Lag 4	1.9412	0.1736	14.1180	0.0069	4
Note – Calculated by the authors					

The Granger causality test results generally do not support a robust causal relationship. At lag 4, a weak or unstable causal relationship from changes in fixed capital investment to changes in R&D spending may be suspected. However, this result requires further verification using more comprehensive data.

At the second stage of the study, the relationship between R&D expenditures and economic growth was assessed. The modeling results are presented in Tables 8-10.

The model results, based on differenced data, indicate that changes in economic growth with a two-period lag have a positive and statistically significant effect on changes in R&D investment (p = 0.008). Changes in the share of the working-age population with a three-period lag exert a negative effect on changes in R&D investment (p = 0.016). Overall, the results suggest that R&D investment responds to the dynamics of economic growth and is sensitive to shifts in labor market conditions rather than to their levels.

Table 8 – Characteristics of VAR model

Model:	VAR	Log Likelihood	-46.0114
Method:	OLS	AIC	-0.0124867
Date:	Wed, 09, Jul, 2025	BIC	1.92919
Time:	05:39:50	HQIC:	0.366549
No. of Equations:	3.00000	FPE:	2.09448
Nobs:	20.0000	Det(Omega_mle):	0.466256
Note – Calculated by the authors based on the VAR model			

Table 9 – Results of the VAR model for R&D expenditures

	coef	std err	t-stat	prob
const	0.217606	0.411099	0.529	0.597
L1. Δ R&D	-0.011579	0.326445	-0.035	0.972
L1. Δ GDP_Growth	0.123087	0.196586	0.626	0.531
L1. Δ Workforce	-0.787971	1.045943	-0.753	0.451
L2. Δ R&D	0.573420	0.457643	1.253	0.210
L2. Δ GDP_Growth	0.456533	0.172796	2.642	0.008
L2. Δ Workforce	1.457245	0.810066	1.799	0.072
L3. Δ R&D	-0.399682	0.371714	-1.075	0.282
L3. Δ GDP_Growth	0.006057	0.188193	0.032	0.974
L3. Δ Workforce	-1.608152	0.665970	-2.415	0.016
L4. Δ R&D	0.037462	0.366472	0.102	0.919
L4. Δ GDP_Growth	-0.014242	0.256039	-0.056	0.956
L4. Δ Workforce	0.148190	0.663125	0.223	0.823
Note – Calculated by the authors based on the VAR model				

Table 10 – Results of the VAR model for economic growth

	coef	std err	t-stat	prob
const	-1.254261	0.783918	-1.600	0.110
L1. Δ R&D	1.595670	0.622493	2.563	0.010
L1. Δ GDP_Growth	-0.545376	0.374868	-1.455	0.146
L1. Δ Workforce	2.130796	1.994495	1.068	0.285
L2. Δ R&D	0.922851	0.872673	1.057	0.290
L2. Δ GDP_Growth	-0.742389	0.329502	-2.253	0.024
L2. Δ Workforce	-1.110866	1.544704	-0.719	0.472
L3. Δ R&D	-0.936341	0.708816	-1.321	0.187
L3. Δ GDP_Growth	-1.200942	0.358863	-3.347	0.001
L3. Δ Workforce	-1.098891	1.269929	-0.865	0.387
L4. Δ R&D	0.063895	0.698821	0.091	0.927
L4. Δ GDP_Growth	-0.317771	0.488237	-0.651	0.515
L4. Δ Workforce	-1.244589	1.264505	-0.984	0.325
Note – Calculated by the authors based on the VAR model				

The model, estimated using differenced data, confirms that changes in R&D investment with a one-period lag have a positive and statistically significant effect on changes in economic growth ($p = 0.010$). In addition, an error-correction–type dynamic is observed: changes in GDP growth in the two- and three-period lags negatively affect current changes in economic growth. In this specification, changes in the share of the working-age population do not have a statistically significant impact on changes in economic growth.

Next, the causal relationship between R&D investment and economic growth rates was analyzed based on the concept of Granger causality. The results of the Granger causality test are presented in Tables 11–12.

Table 11 – Granger test values (the impact of R&D expenditures on economic growth)

Lags	F	p	chi2	p	df
Lag 1	0.1471	0.7054	0.1691	0.6809	1
Lag 2	0.0779	0.9254	0.2017	0.9041	2
Lag 3	2.2315	0.1297	10.0418	0.0182	3
Lag 4	2.2889	0.1251	16.6466	0.0023	4
Note – Calculated by the authors					

The results of the Granger causality test did not reveal a statistically significant causal relationship from changes in R&D expenditures to changes in economic growth for any of the considered lag lengths (from 1 to 4 lags). The p-values of the F-test were well above the 0.05 significance level. Alternative tests (chi-squared test and likelihood ratio test) for lags 3 and 4 show lower p-values ($p < 0.05$). However, F-test results are generally preferred for small samples, and in this case, they do not support causality.

Table 12 – Granger test values (the impact of economic growth on R&D expenditures)

Lags	F	p	chi2	p	df
Lag 1	0.1341	0.7181	0.1542	0.6945	1
Lag 2	5.1056	0.0183	13.2144	0.0014	2
Lag 3	3.7717	0.0357	16.9728	0.0007	3
Lag 4	3.0454	0.0645	22.1483	0.0002	4
Note – Calculated by the authors					

The results of the Granger causality test, conducted on differenced series, indicate a stable causal relationship at lags 2 and 3. Specifically, past changes in GDP growth rates statistically significantly improve the forecast of changes in R&D investment. This provides evidence of one-way Granger causality running from changes in economic growth to changes in R&D investment.

Although the VAR model based on differenced data identifies a statistically significant positive effect of changes in R&D investment with a one-period lag on changes in economic growth, the Granger causality result does not support the existence of causality from changes in R&D expenditures to changes in economic growth. This discrepancy may arise because the Granger test evaluates the joint predictive power of all included lags of a variable, whereas the VAR framework assesses the statistical significance of individual lagged coefficients while controlling for other variables in the system. In addition, the small sample size may reduce the statistical power of the Granger tests.

Based on these results, the study's hypotheses can be summarized as follows.

Hypothesis H1 regarding the relationship between R&D investment and investment in fixed capital is partially confirmed. According to the VAR model in first differences, changes in fixed

capital investment are mainly explained by their own lagged changes, particularly at lag 3, while no statistically significant effect of changes in R&D expenditures on fixed capital investment is detected. In contrast, in the equation for changes in R&D investment, a statistically significant negative effect of changes in fixed capital investment at lag 3 ($p = 0.013$) is observed, which may indicate a delayed substitution effect between the two types of investment. The Granger causality test does not confirm causality from changes in R&D expenditures to changes in fixed capital investment for any of the considered lags. In the reverse direction (changes in fixed capital – changes in R&D investment), causality is also not detected for lags 1-3; however, at lag 4, the results are mixed: the chi-squared test ($p = 0.069$) and LR test ($p = 0.0304$) suggest a possible link, while the F-test ($p = 0.1736$) does not support it.

Hypothesis H2, regarding the effect of R&D investment on Kazakhstan's economic growth, is also partially confirmed. The VAR model reveals a positive and statistically significant impact of changes in R&D investment with a one-period lag on changes in economic growth, as well as a reverse effect in which changes in GDP growth at lag 2 positively affect changes in R&D investment. However, the Granger causality test does not confirm causality from changes in R&D expenditures to changes in GDP growth according to the F-test at any lag. At the same time, alternative tests (the chi-squared and LR tests) at lags 3 and 4 yield lower p-values, indicating a potentially weak relationship. In contrast, Granger causality from changes in GDP growth rates to changes in R&D investment is robustly confirmed at lags 2 and 3 by all tests, pointing to a predominantly one-way dynamic relationship between these variables.

Conclusion

This study provides a comprehensive empirical analysis of the dynamic interactions between R&D expenditures, investment in fixed capital, and economic growth in Kazakhstan over the period 2000–2024. Using a VAR framework estimated in first differences, combined with stationarity testing and Granger causality analysis, the study focuses on short-term dynamics and predictive relationships among changes in these variables. This approach allows for a more precise interpretation of innovation-driven growth processes in a developing economy by emphasizing adjustments and fluctuations rather than long-run levels.

The results indicate that changes in fixed capital investment are primarily driven by their own past changes, particularly at a three-period lag, while changes in R&D expenditures do not exert a statistically significant direct influence on changes in capital investment. At the same time, a lagged negative effect of changes in fixed capital investment on changes in R&D expenditures is identified, suggesting a delayed substitution effect between these two forms of investment. Granger causality tests largely confirm the absence of a strong predictive relationship between the two, with only weak and lag-specific indications that warrant further investigation.

With respect to economic growth, the VAR results show that changes in R&D investment with a one-period lag have a positive and statistically significant effect on changes in GDP growth, underscoring the role of innovation in shaping short-term growth dynamics. In addition, changes in economic growth positively influence subsequent changes in R&D expenditures, indicating that innovation activity is responsive to improvements in macroeconomic conditions. Although Granger causality tests do not support causality running from changes in R&D expenditures to changes in economic growth, they consistently confirm one-way causality from changes in GDP growth to changes in R&D investment, highlighting economic performance as a key driver of innovation dynamics.

Overall, the findings partially confirm the proposed hypotheses. Hypothesis H1, which posits a relationship between R&D investment and fixed capital investment, receives limited support, with evidence pointing to a lagged negative effect from changes in fixed capital investment to changes in R&D expenditures. Hypothesis H2, concerning the positive impact of R&D investment on economic growth, is also partially confirmed: while the VAR model identifies a significant short-term effect of changes in R&D investment on growth dynamics, Granger causality results emphasize the predictive role of economic growth for R&D activity rather than the reverse. These results underscore the complexity and lag-dependent nature of interactions between innovation, investment, and growth in Kazakhstan.

This study contributes to the literature by providing empirical evidence on the short-term dynamics of R&D, investment, and economic growth in an emerging economy context using differenced data. From a policy perspective, the findings suggest that

increases in R&D investment alone may not immediately translate into sustained economic growth, and that a stable and supportive macroeconomic environment is crucial for stimulating innovation activity and fostering long-term development.

Acknowledgments: This research was funded by the National Bank of the Republic of Kazakhstan (Grant «Optimal level of investment to achieve sustainable economic growth in Kazakhstan». Agreement No.237 NB 29.05.2024).

References

Aghion P., Howitt P. (1992). A model of growth through creative destruction. *Econometrica*, 60(2), 323–351. https://doi.org/10.2307/2951599

Akorda (2024). Выступление Президента Касым-Жомарта Токаева на расширенном заседании Правительства. https://www.akorda.kz/ru/speeches/internal_political_affairs/in_speeches_and_addresses/vystuplenie-prezidenta-kasym-zhomarta-tokaeva-na-rasshirennom-zasedanii-pravitelstva

Arana Barbier P.J. (2023). The Relationship between Scientific Production and Economic Growth Through R&D Investment: A Bibliometric Approach. *Journal of Scientometric Research*, 12 (3), 596-602. https://doi.org/10.5530/jscires.12.3.057

Baxultanov D., Kurmanov N., Kerimkulova, M., Syrlybayeva N. (2022). Analysis and assessment of the innovation development state of Kazakhstan. *Journal of Economic Research & Business Administration*, *141*(3), 138–150. https://doi.org/10.26577/be.2022.v141.i3.13

Bilbao-Osorio B., Rodríguez-Pose A. (2004). From R&D to innovation and economic growth in the EU. *Growth and Change*, 35 (4), 434–455. https://doi.org/10.1111/j.1468-2257.2004.00256.x

Bottazzi L., Peri G. (2003). Innovation and spillovers in regions: Evidence from European patent data. *European Economic Review*, 47 (4), 687–710. https://giovanniperi.ucdavis.edu/uploads/5/6/8/2/56826033/bottazzi_peri_2003.pdf

Crescenzi R., Rodríguez-Pose A., Storper M. (2007). The territorial dynamics of innovation: A Europe – United States comparative analysis. *Journal of Economic Geography*, 7, 673–709. https://doi.org/10.1093/jeg/lbm030

Danabayeva R.I., Shedenov U.K. (2015). Sustainable development of innovations in Kazakhstan: on the way to a knowledge-based economy. *Journal of Economic Research & Business Administration*, 100(6), 80–87. https://be.kaznu.kz/index.php/math/article/view/537

Ercan Merve, Temiz D., Gokmen A. (2025). The impact of technology on economic growth in Turkey. *International Journal of Economic and Business Research*, 6, 465-485. https://doi.org/10.1504/IJEBR.2025.148944

Ginevicius Romualdas (2023). Assessment of the Effectiveness of investment in R&D by European Union Countries. *Amfiteatru Economic*, 251 (6), 251-264. https://doi.org/10.24818/EA/2023/62/251

Huseynli N. (2023). Examination of the Relationship Between Economic Growth and Research and Development Expenditures in Azerbaijan, Kazakhstan and Kyrgyzstan. *Finance: Theory and Practice*, 27 (2), 28-37. https://financetp.fa.ru/jour/article/view/2075/1153

Jaffe A. B. (1989). Real effects of academic research. *The American Economic Review*, 79 (5), 957–970. https://www.jstor.org/stable/1831431

Kusmoldaeva Zh., & Khudaybergenova S. (2017). Development of innovation in Kazakhstan: the main elements and direction. *Journal of Economic Research & Business Administration*, *121*(3), 36–41. https://be.kaznu.kz/index.php/math/article/view/1924

Министерство науки и высшего образования Республики Казахстан. (2022). Национальная Академия наук Республики Казахстан при Президенте Республики Казахстан. Национальный доклад по науке. https://nauka-nanrk.kz/assets/Doklad%20ru.pdf

Mudronja Gorana, Jugovic Alen, Skalamera-Alilovic Dunja. (2019). Research and development and economic growth: EU port regions. *Proceedings of Rijeka Faculty of Economics*, 37(2), 587-602. https://doi.org/10.18045/zbefri.2019.2.587

Nauryzbaeva A., Nepshina, V., & Muratova, D. (2024). Development of the innovation ecosystem in the Republic of Kazakhstan. *ECONOMIC Series of the Bulletin of the L N Gumilyov ENU*, (3), 193–208. https://doi.org/10.32523/2789-4320-2024-3-193-208

Нурмаганбетов А., & Тугушев Р. (2024). Перспективы и риски при инвестировании в высокотехнологичные предприятия Казахстана. *Scientific Collection «InterConf»*, (195), 37–43. https://archive.interconf.center/index.php/conference-proceeding/article/view/5786

Rodriguez-Pose A. (1999). Innovation prone and innovation averse societies: Economic performance in Europe. *Growth and Change*, 30 (1), 75–105. https://doi.org/10.1111/0017-4815.00105

Romer P.M. (1990). Endogenous Technological Change. *Journal of Political Economy*, 98, 71-102. http://dx.doi.org/10.1086/261725

Sadyrova M., Yusupov K. & Imanbekova B. (2021). Innovation processes in Kazakhstan: development factors. *J Innov Entrep* 10, 36. https://doi.org/10.1186/s13731-021-00183-3

Seitkan G.G., Karacsoni P., Zaitenova N.K., Қonysbay A.K. (2024). R&D expenditures and their impact on innovation in the digital era: a Kazakhstan perspective. *Economy: strategy and practice*, 19(3), 19-31. https://doi.org/10.51176/1997-9967-2024-3-19-31

Simut Ramona, Bodog S.-A., Badulescu A., Badulescu D., Dzitac S., Sehleanu M. (2025). Exploring the nexus between innovation and economic growth. Empirical evidence from European countries. *Economic Computation and Economic Cybernetics Studies and Research*, 59(1), 52-67. https://doi.org/10.24818/18423264/59.1.25.04

Wang S., Fan J., Zhao D., Wang S. (2016). Regional innovation environment and innovation efficiency: The Chinese case. *Technology Analysis Strategic Management*, 28 (4), 396–410. https://doi.org/10.1080/09537325.2015.1095291

WIPO. (2024). Рейтинг Казахстана в Глобальном инновационном индексе 2024 года. WIPO. Kazakhstan ranking in the Global Innovation Index 2024. https://www.wipo.int/gii-ranking/en/kazakhstan

Wynn Katherine, Liu Mingji, Cohen Jasmine. (2022). Quantifying the economy-wide returns to innovation for Australia. *Australian Economic Papers*, 61(3), 591-614. https://doi.org/10.1111/1467-8454.12262

Xuan Vu Ngoc (2025). Nexus of innovation, renewable energy, FDI, trade openness, and economic growth in Germany: New insights from ARDL method. *Renewable Energy*, 247. https://doi.org/10.1016/j.renene.2025.123060

References

Aghion P., Howitt P. (1992). A model of growth through creative destruction. *Econometrica*, 60(2), 323–351. https://doi.org/10.2307/2951599

Akorda (2024). Vystuplenie Prezidenta Kasym-Zhomarta Tokaeva na rasshirennom zasedanii Pravitel'stva. [Speech by President Kassym-Jomart Tokayev at an extended meeting of the Government]. https://www.akorda.kz/ru/speeches/internal_political_affairs/in_speeches_and_addresses/vystuplenie-prezidenta-kasym-zhomarta-tokaeva-na-rasshirennom-zasedanii-pravitelstva

Arana Barbier P.J. (2023). The Relationship between Scientific Production and Economic Growth Through R&D Investment: A Bibliometric Approach. *Journal of Scientometric Research*, 12 (3), 596-602. https://doi.org/10.5530/jscires.12.3.057

Baxultanov D., Kurmanov N., Kerimkulova M., Syrlybayeva N. (2022). Analysis and assessment of the innovation development state of Kazakhstan. *Journal of Economic Research & Business Administration*, 141(3), 138–150. https://doi.org/10.26577/be.2022.v141.i3.13

Bilbao-Osorio B., Rodríguez-Pose A. (2004). From R&D to innovation and economic growth in the EU. *Growth and Change*, 35 (4), 434–455. https://doi.org/10.1111/j.1468-2257.2004.00256.x

Bottazzi L., Peri G. (2003). Innovation and spillovers in regions: Evidence from European patent data. *European Economic Review*, 47 (4), 687–710. https://giovanniperi.ucdavis.edu/uploads/5/6/8/2/56826033/bottazzi_peri_2003.pdf

Crescenzi R., Rodríguez-Pose A., Storper M. (2007). The territorial dynamics of innovation: A Europe – United States comparative analysis. *Journal of Economic Geography*, 7, 673–709. https://doi.org/10.1093/jeg/lbm030

Danabayeva R. I., Shedenov U. K. (2015). Sustainable development of innovations in Kazakhstan: on the way to a knowledge-based economy. *Journal of Economic Research & Business Administration*, 100(6), 80–87. https://be.kaznu.kz/index.php/math/article/view/537

Ercan Merve, Temiz D., Gokmen A. (2025). The impact of technology on economic growth in Turkey. *International Journal of Economic and Business Research*, 6, 465-485. https://doi.org/10.1504/IJEBR.2025.148944

Ginevicius Romualdas (2023). Assessment of the Effectiveness of investment in R&D by European Union Countries. *Amfiteatru Economic*. 251 (6). 251-264. https://doi.org/10.24818/EA/2023/62/251

Huseynli N. (2023). Examination of the Relationship Between Economic Growth and Research and Development Expenditures in Azerbaijan, Kazakhstan and Kyrgyzstan. *Finance: Theory and Practice*, 27 (2), 28-37. https://doi.org/10.26794/2587-5671-2023-27-2-28-37

Jaffe A. B. (1989). Real effects of academic research. *The American Economic Review*, 79 (5), 957–970. https://www.jstor.org/stable/1831431

Kusmoldaeva Zh., Khudaybergenova S. (2017). Development of innovation in Kazakhstan: the main elements and direction. *Journal of Economic Research & Business Administration*, *121*(3), 36–41. https://be.kaznu.kz/index.php/math/article/view/1924

Ministry of Science and Higher Education of the Republic of Kazakhstan. (2022). Nacional'naja Akademija nauk Respubliki Kazahstan pri Prezidente Respubliki Kazahstan. Nacional'nyj doklad po nauke. [National Academy of Sciences of the Republic of Kazakhstan under the President of the Republic of Kazakhstan. National Science Report]. https://nauka-nanrk.kz/assets/Doklad%20ru.pdf

Mudronja Gorana, Jugovic Alen, Skalamera-Alilovic Dunja. (2019). Research and development and economic growth: EU port regions. *Proceedings of Rijeka Faculty of Economics*, 37(2), 587-602. https://doi.org/10.18045/zbefri.2019.2.587

Nauryzbaeva A., Nepshina, V., & Muratova, D. (2024). Development of the innovation ecosystem in the Republic of Kazakhstan. *ECONOMIC Series of the Bulletin of the L N Gumilyov ENU*, (3), 193–208. https://doi.org/10.32523/2789-4320-2024-3-193-208

Nurmaganbetov, A., & Tugushev, R. (2024). Perspektivy i riski pri investirovanii v vysokotehnologichnye predprijatija Kazahstana. [Prospects and risks of investing in high-tech enterprises in Kazakhstan]. *Scientific Collection «InterConf»*, 195, 37–43. https://archive.interconf.center/index.php/conference-proceeding/article/view/5786

Rodriguez-Pose A. (1999). Innovation prone and innovation averse societies: Economic performance in Europe. *Growth and Change*, 30 (1), 75–105. https://doi.org/10.1111/0017-4815.00105

Romer P.M. (1990). Endogenous Technological Change. *Journal of Political Economy*, 98, 71-102. http://dx.doi.org/10.1086/261725

Sadyrova M., Yusupov K. & Imanbekova B. (2021). Innovation processes in Kazakhstan: development factors. *J Innov Entrep* 10, 36. https://doi.org/10.1186/s13731-021-00183-3

Seitkan G.G., Karacsoni P., Zaitenova N.K., Қonysbay A.K. (2024). R&D expenditures and their impact on innovation in the digital era: a Kazakhstan perspective. *Economy: strategy and practice*, 19(3), 19-31. https://doi.org/10.51176/1997-9967-2024-3-19-31

Simut Ramona, Bodog S.-A., Badulescu A., Badulescu D., Dzitac S., Sehleanu M. (2025). Exploring the nexus between innovation and economic growth. Empirical evidence from European countries. *Economic Computation and Economic Cybernetics Studies and Research*, 59(1), 52-67. https://doi.org/10.24818/18423264/59.1.25.04

Wang S., Fan J., Zhao D., Wang S. (2016). Regional innovation environment and innovation efficiency: The Chinese case. *Technology Analysis Strategic Management*, 28 (4), 396–410. https://doi.org/10.1080/09537325.2015.1095291

WIPO. (2024). Rejting Kazahstana v Global'nom innovacionnom indekse 2024 goda. [Kazakhstan ranking in the Global Innovation Index 2024]. https://www.wipo.int/gii-ranking/en/kazakhstan

Wynn K., Liu M., Cohen J. (2022). Quantifying the economy-wide returns to innovation for Australia. *Australian Economic Papers*, 61(3), 591-614. https://doi.org/10.1111/1467-8454.12262

Xuan Vu Ngoc (2025). Nexus of innovation, renewable energy, FDI, trade openness, and economic growth in Germany: New insights from ARDL method. *Renewable Energy*, 247. https://doi.org/10.1016/j.renene.2025.123060

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Received: 23 September 2025
Accepted: 20 December 2025