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CREATIVE ECONOMY AT THE NEXUS OF INNOVATION, DIGITALIZATION AND EDUCATION: ARDL AND NARDL APPROACH FROM KAZAKHSTAN

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ABSTRACT

The purpose of the research work is to assess the indicators of innovation, digitalization and knowledge that have an impact on the creative economy. For this purpose, the following indicators were analyzed: total GVA for the creative industry, the share of GVA for the creative industry in GDP, government expenditure on education, research and development expenditure, information technology exports, internal R&D costs by branches of science, the volume of innovative products (goods, services), and the share of innovative products (goods, services). The data covers the period 2004-2022 and is taken from global and domestic data sources. In order to obtain comprehensive results of the study, two models were used: Linear Autoregressive Distributed Lag (ARDL) and Non-Linear Autoregressive Distributed Lag (NARDL). According to the results of the model, indicators with linear and nonlinear effects in the long and short term were identified. The practical significance of the study lies in the finding that the negative impact of internal Research and Development indicates the need to strictly monitor the progress and results of funds allocated to this sector and scientific projects. Although government spending on education has negative effects in the short term, it has positive effects in the strategic long run. It is important to highlight that for Kazakhstan, it is high priority to support creative economy sectors that have practical importance and result in production. The study also adds new empirical evidence and extends the existing literature on the creative economy.

Keywords: *female employment, economic growth, birth rate, digitalization, ARDL*

1. INTRODUCTION

The creative economy is one of the fastest-growing economic models, even though the idea first appeared in scientific and media publications only over two decades ago. The creative economy is also making a significant contribution to global development. Industries that originate from individual creativity, talent and skills-and that use intellectual property to create wealth and jobs-are sectors of the creative economy (Potts & Cunningham, 2008). What distinguishes the traditional economy from the creative economy? The difference between the creative economy and the traditional economy lies in the creative person. Creativity is an unlimited resource for generating ideas and a source of innovation. The creative economy is a «transaction of creative

goods» (Howkins, 2002), while a creative class is a group that offers a creative approach to the problem and non-standard solutions (Florida, 2003). According to Florida, a person's talent may not be directly related to education but to locality, and specifically to the level of economic development of the region. Florida has denied the existence of a direct correlation between the concentration of universities and the concentration of human capital. Obviously, the presence of a university is a prerequisite for talent, but this cannot be the sole determinant. Higher education broadens the student's horizons. The creative economy, in synergy with the knowledge-based economy, has the potential to transform cities and regions into economically more vibrant and attractive places to live (Veselá & Klimová, 2014). This demonstrates the importance of information in the creative economy.

To ensure that the required mechanisms can be activated to accelerate economic growth through the creative economy, it is crucial to answer the fundamental question of what influences the development of the creative economy and how. The effects of various factors on the creative economy are the focus of researchers around the world. In reviewing a large body of literature, it has been observed that indicators related to innovation, knowledge, and technology are increasingly elevated in terms of the creative economy, thus some of the most important studies will be discussed in the Literature Review section. Over the past 10 years, there has been an increase in research exploring the relationship between education and the creative economy (Zhuparova et al., 2023). Mark Matthews tried to explain the relationship between creative industries, science and innovation policy through the categories of neglect, uncertainty and risk. The author believes that we should pay attention to the fact that the transition from non-accounting to the categories of uncertainty and risk in all spheres helps creatively (Matthews, 2008). The globalization-driven access to global markets and the growing importance of ICT are among the many reasons for the growth of creative industries (Potts & Cunningham, 2008). Both developing and developed countries consider the creative economy as a strategic direction when conducting public policy (Vlasenko, 2023). Examples of this include the Republic of Kazakhstan's «Concept of creative industries development for 2021-2025» program, Egypt's «Egypt Vision 2030» program, and Indonesia's «Ministry of Tourism and Creative Economy Strategic Plan 2020-2024» program (CEO, 2024). With the assistance of the government and additional elements, global exports of creative goods and services have grown steadily over the past 10 years, with only a slight slowdown during the pandemic.

Increasing GDP in countries around the world through the creative economy has been a good motivation for other countries. In this regard, Kazakhstan has considered the strategic development of the creative economy at the state level. The development of the creative economy across the country is currently afflicting a wide variety of issues. Another problem is that the creative economy industries are developed and concentrated only in large cities (Temerbulatova et al., 2021). The creative economy of Kazakhstan could benefit enormously from the development of city marketing and place branding strategies through strategic influencer partnerships (Bolatbek et al., 2024). The development of the creative industry can become one of the foundations of the transition to a post-industrial and highly intelligent economic system of Kazakhstan (Dzhakisheva, 2024). Nevertheless, in the Republic, the strategic documents of the cultural sector do not contain indicators for the creation of creative industries. It is necessary to unify the Concept of Cultural Policy and the Concept of Development of Creative Industries for 2021-2025 in order to determine joint tasks (Argynbekov & Zeynelgabdin, 2024).

Thus, the aim of this research paper is to assess the symmetric and asymmetric impact of available innovation, digitalization and education variables on the creative economy in Kazakhstan. For a comprehensive analysis, both the Linear Autoregressive Distributed Lag (ARDL) and Non-Linear Autoregressive Distributed Lag (NARDL) methods will be used, and all necessary

tests will be done to find out whether the model is valid. This will enable the authors to answer the following research questions:

RQ 1: To what extent do innovation indicators play a role in Kazakhstan's creative economy?

RQ 2: To what extent do digitalization indicators play a role in Kazakhstan's creative economy?

RQ 3: To what extent do education indicators play a role in Kazakhstan's creative economy?

Thus, the paper is organized as follows: Introduction, Literature Review, Methodology and Materials, Results and Discussion, and Conclusion.

2. LITERATURE REVIEW

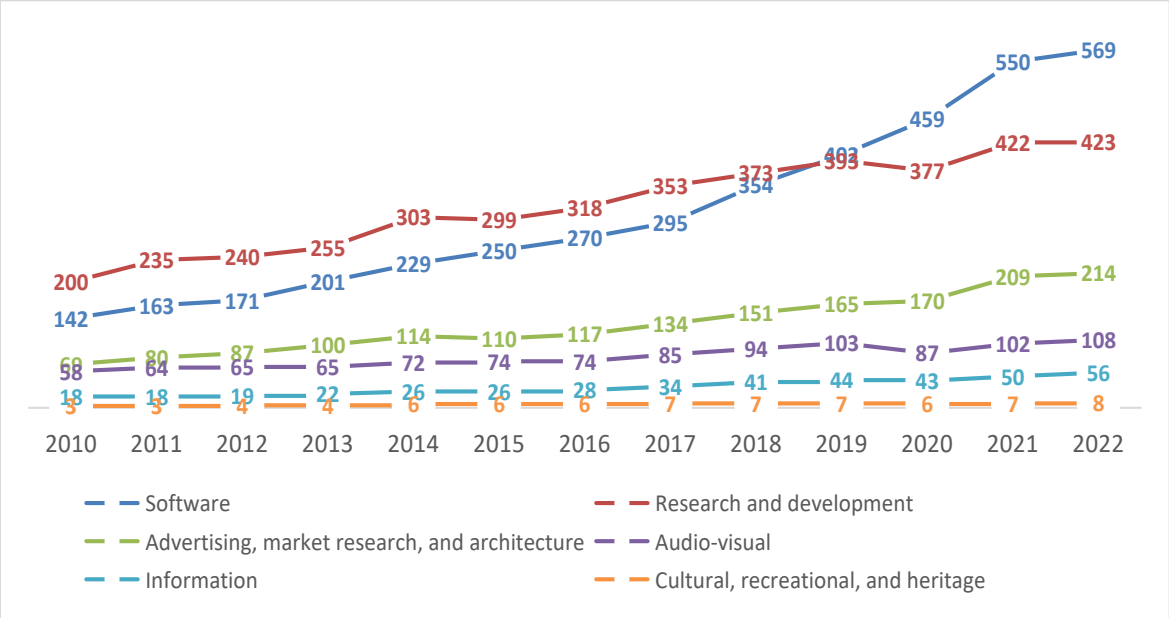
This section of the research includes a summary of key sources from recent decades that are relevant to the study of the creative economy, innovation, knowledge, and digitalization. The creative economy permeates all sectors and is not a separate sector; it is associated with the production of new ideas that ultimately become new products, services, or, in some cases, innovations in processes and products within old networks (Bridgstock & Hearn, 2012). The creative economy is based on concepts and knowledge originating from human creativity (Sukomardojo et al., 2022). Combining knowledge from previously unrelated fields is one of the core aspects of creative thinking (Skippington, 2016). Innovation and creativity are the basis of all industries (Maulina, 2020). Creativity was identified as a key ingredient for job creation, innovation, trade, and as a contributor to social inclusion based on cultural diversity (Lyck, 2013).

Digital technologies and artificial intelligence have led to job losses, and one of the ways to save jobs and create them is through creative industries (Polishchuk et al., 2025). Creative industries have a significant impact on the innovative activity of national economies through the development and implementation of innovations both within the framework of their economic activities and by stimulating innovation in other sectors (Kalenyuk & Kuznetsova, 2022). The implementation of effective innovation policies and appropriate support measures in various countries demonstrates a high level of economic development, in which small and medium-sized enterprises play an important role (Nurumov, 2023). Companies are also gradually realizing that innovation may provide their only sustainable competitive advantage, and that future survival depends on their ability to identify and capitalize on new ways of thinking, meet demand, and stay ahead of their knowledge competitors (Mann & Chan, 2011). Since it is easier to create and run small and medium-sized enterprises (SMEs) compared to large businesses, the development of creative industries through SMEs is quite likely to be effective (Maia & Frogeri, 2023). In many developing countries, small businesses, such as traditional crafts, are presented as part of the creative industry sector (Fahmi, 2017). This is a sign that the sectors included in the creative economy can be different in each country and that the average systemization is weak around the world (Toni, 2025). The creative impulse for the development of an innovation cluster is a defining condition for increasing the competitiveness of the economy (Brizhak & Polyakov, 2022).

Under present conditions, further innovative development and the achievement of high competitiveness in the country's economy are among the priority areas, and the quality of human capital largely determines their success (Saparova et al., 2023). The main driving force of the creative economy is not only technology or information, but also human creativity, along with creative and unique products that bring together culture, spirit and habits (Amory, 2024). Knowledge Management Systems and IT systems are very important in increasing the creative aspect within organizations (Ummul Hidayah, 2024). Transforming universities' educational policies towards the creative economy will help them retain talents (Saehu et al., 2023). It is

clear that combining students' talents and personal skills, technologies, and business pillars in higher education will give impetus to the development of the creative economy (Santos Vieira de Jesus, 2019). Both the creative economy and the digital economy are part of the global economic transformation, as well as a focus of academic research and public policy (Knell & Oakley, 2007). The introduction of advanced technologies also plays an important role in the development of entrepreneurship in the creative economy (Panjawa, 2024). Governments of countries support the creative economy for various purposes (Yusri et al., 2022; Setiawati et al., 2023; Umiyati et al., 2023; Bulochnikov & Evmenov, 2025). For business sectors in the creative economy, digitalization will help improve efficiency and access to markets (Hidayati et al., 2022; Martial et al., 2024). The creative industries have become an important tool for the integration of modern digital trends and technologies into the cultural space of countries (Vlasenko & Pozniak, 2020). Digitalization has led to the transformation of the creative industries (CEO, 2024). Moreover, digitalization and the transformation of the whole employment structure contribute to the growth of the creative economy sector and increase its share in the national economy, even in times of crisis (Serikkyzy et al., 2023).

Figure 1. Global exports of creative services by service category, 2010–2022 (billions of U.S. dollars)



Source: UNCTAD

The dominance of Software in the export of creative services in the last 10 years is a sign of the rapid development of digitization. The COVID-19 pandemic had a positive effect on digitization overtaking other service categories (Haroon & Zeeshan, 2023). Digitization also has a significant contribution to the fact that the export of creative services has overtaken the export of creative goods (Shevchenko, 2023). Technological innovation and industrial restructuring are significant ways to improve the green economy efficiency level in the digital economy, and the digital economy, in return, acts as an accelerator in many ways. There is a need to provide a more systematic ICT framework for research and decision-making (Feher et al., 2017). It is crucial to create an innovative environment to develop the region's digital reconstruction and revitalize creative industries (Zhao et al., 2024). The creative economy is an economy that creates new jobs (Sava & Badulescu, 2016; Baitenizov et al., 2019; Muchira, 2023). The young generation should know what specialists exist in the creative industry, since one of the problems is not knowing or not fully knowing what work exists in these areas (Ivaschenko & Shanti, 2025).

Based on the above research questions and literature review, the authors test the following hypotheses:

H_0: Innovation has a positive impact on the creative economy in both the short and long term.

H_1: Digitalization has a positive impact on the creative economy in both the short and long term.

H_2: Education has a positive impact on the creative economy in both the short and long term.

3. METHODOLOGY AND MATERIALS

3. 1. DATA

This study examines the impact of the main factors on the Total GVA for the creative industry in the Republic of Kazakhstan. The study uses data for the period from 2004 to 2022, which were obtained using the World Data Bank (WDI), ourworldindata.org, and TheGlobalEconomy.com (https://www.theglobaleconomy.com). The explanatory variables in this study are Government expenditure on education (GEE), Internal R&D costs by branches of science (IRDC), Volume of innovative products (VIP), and Share of innovative products in GDP (SIP).

The study also examines the impact of the main factors on GVACIGDP in the Republic of Kazakhstan. In this case, the explanatory variables are Government expenditure on education (GEE), Research and development expenditure, as a percentage of GDP (RDE), Information technology exports (ITE), Internal R&D costs by branches of science (IRDC), Volume of innovative products (VIP), and Share of innovative products (SIP).

Definitions and measurements of all indicators are given in Table 1 below.

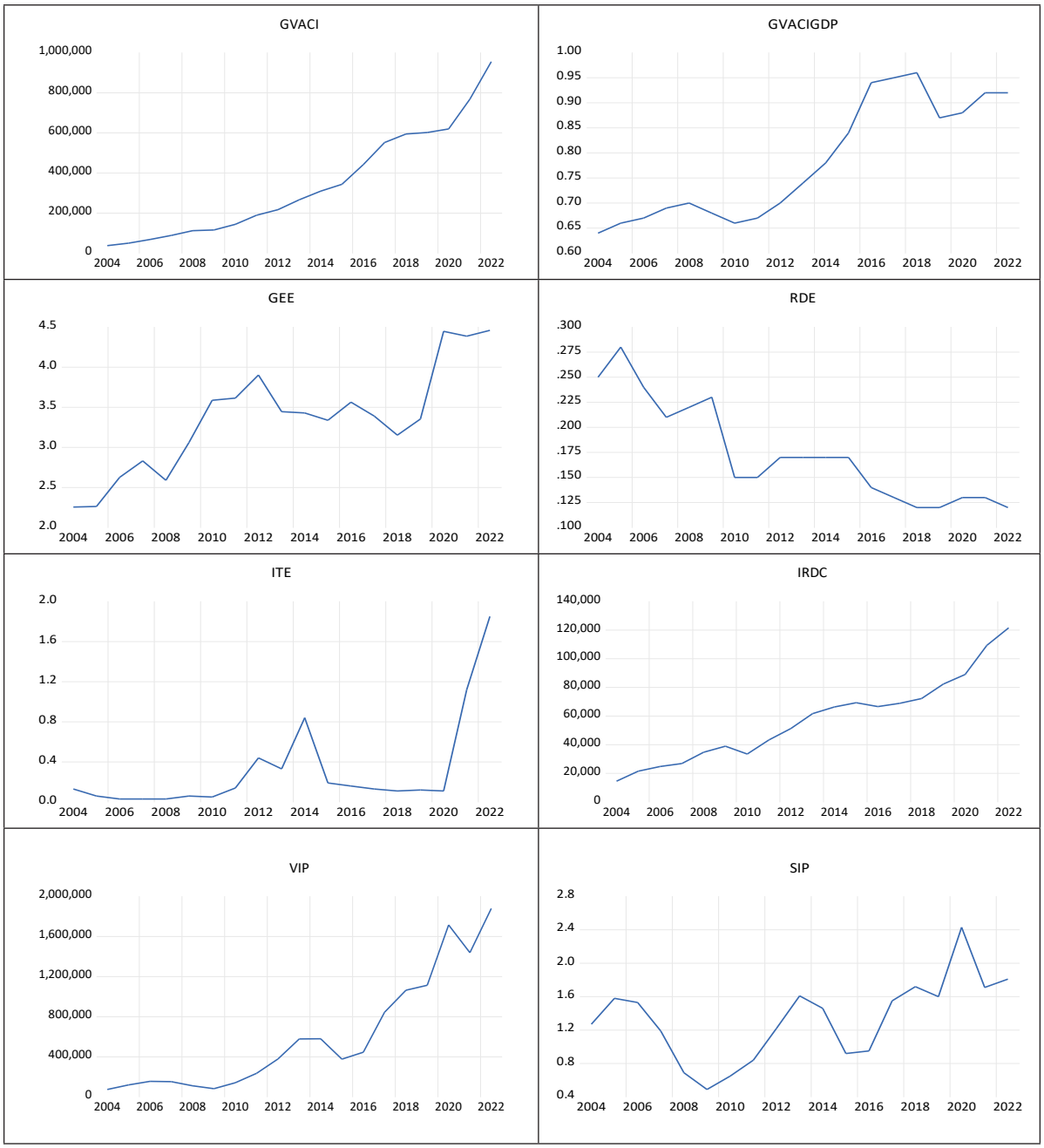
Table 1. Model variables and sources

Variables	Definitions	Sources
GVACI	Total GVA for the creative industry (million tenge)	Bureau of National statistics of Kazakhstan (2025) https://stat.gov.kz/
GVACIGDP	Share of GVA for the creative industry in GDP (%)	Our World in Data (2025) https://ourworldindata.org
GEE	Government expenditure on education (total % of GDP)	World Development Indicators (WDI) (2025)
RDE	Research and development expenditure (% of GDP)	TheGlobalEconomy.com(2025) https://www.theglobaleconomy.com
ITE	Information technology exports (% of total goods export)	TheGlobalEconomy.com (2025) https://www.theglobaleconomy.com
IRDC	Internal R&D costs by branches of science	Bureau of National statistics of Kazakhstan (2025) https://stat.gov.kz/
VIP	Volume of innovative products (goods, services)	Bureau of National statistics of Kazakhstan (2025) https://stat.gov.kz/
SIP	Share of innovative products (goods, services) in GDP (%)	Bureau of National statistics of Kazakhstan (2025) https://stat.gov.kz/

Source: Compiled by the authors

The dynamic change of all indicators presented in the table for the period 2004–2022 is depicted in the following graph:

Figure 2. Evolution of all variables for Kazakhstan (2004–2022)



Source: Compiled by the authors

It is clear from the analysis of the graph shown in Figure 2 that the study variables are suitable for analysis. The graph shows obvious, consistent and stable time patterns, indicating that changes in the variables are suitable for further study.

3. 2. METHODS

Taking into account the results of the literature review presented in the previous section, this study examines the relationship between GVACI (Creative Industry GVACI) for the period 2004-2022 and innovation and digital indicators of the Republic of Kazakhstan, such as Government expenditure on education, Research and development expenditure, Information technology exports, Internal R&D costs by branches of science, Volume and share of innovative products. GVACI is determined by the following equation:

$$GVACI = f(GEE, RDE, ITE, IRDC, VIP, SIP) \quad (1)$$

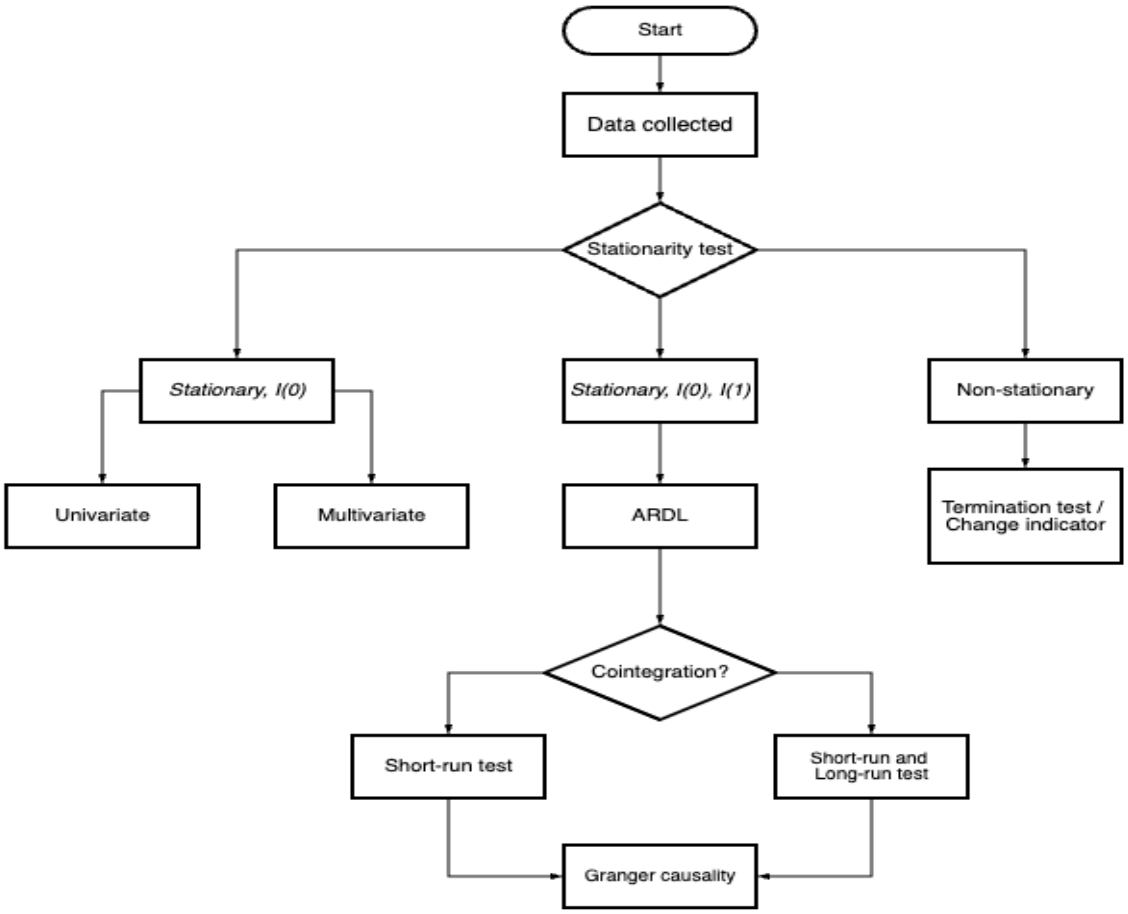
where all of their definitions and measurements are given in Table 1.

Also, the relationship between the share of GVA in the creative industry in GDP (GVACIGDP) and the same explanatory variables is estimated using the following regression model:

$$GVACIGDP = f(GEE, RDE, ITE, IRDC, VIP, SIP) \quad (2)$$

The block diagram in Figure 3 illustrates the overall structure of the model's analysis.

Figure 3. Methodological framework



Source: Compiled by the authors

First, the stationarity of the time series is checked using the algorithm shown in Figure 3. The study variables must meet specific stationarity requirements in order to use the ARDL/NARDL model. In other words, the variables ought to be I(0)/I(1), just I(0), or purely I(1) (Alimi, 2014). The Dickey & Fuller (1979) test was used to evaluate that. The ideal lag was chosen using the Akaike (1974) information criterion (AIC). The residuals' normalcy was examined using the Jarque-Bera test (1980). The Breusch (1978) and Godfrey (1978) tests were employed to check for serial correlation. The heteroscedasticity was examined using the Breusch-Pagan-Godfrey (1979) test. The CUSUM (Cumulative sum of recursive residuals) and CUSUMSQ (Cumulative sum of squared recursive residuals) tests were used to examine the stability of the model (Brown et al., 1975).

During the study, based on the results of the ADF test, it was found that all the independent variables under study are stationary at the level of I(0) or at the first differences I(1), while the

dependent variable GVACI is stationary only in the case of the 1st difference with Trend and intercept. Therefore, for the first model (equation 3), the LOG(GVACI) variable was used. For the GVACIGDP variable, which is stationary at the level of the first differences I(1), the case of 1st difference without Intercept and trend (equation 4) was used. The ARDL methodology was also used, and the order of integration of variables was considered to determine the suitability of the ARDL model for the study, using a special test. A maximum of one lag was selected (Table 5).

The nonlinear NARDL model and linear ARDL model were estimated using the first difference, and both long-term and short-term relationships between the variables were analyzed. Based on the results of the Granger causality test using the first difference, the linear ARDL model was constructed and the long-run and short-run analyses of the relationship between the variables were conducted (Moussir, 2025).

In a linear autoregressive model with distributed lags, the ARDL procedure determines whether cointegration exists between selected variables. The bounds test checks for long-run relationships, and the results of the bounds test are presented in Table 6.

Two main models were constructed. In Model 1, the linear model specification was converted to a semilogarithmic one. In the nonlinear autoregressive model with distributed lags, the NARDL procedure is defined by equation 3:

$$\Delta LOG(GVACI_t) = \beta_0 + \sum_{k=1}^{m} \beta_1 \Delta LOG(GVACI_{t-k}) + \sum_{k=0}^{n} \beta_2 \Delta GEE_{t-k} + \\ + \sum_{k=0}^{p} \beta_3 \Delta IRDC_{t-k} + \sum_{k=0}^{q} \beta_4 \Delta VIP_{t-k} + \sum_{k=0}^{r} \beta_5 \Delta SIP_{t-k} + \gamma_1 GEE_{t-i} \\ + \gamma_2 IRDC_{t-i} + \gamma_3 VIP_{t-i} + \gamma_4 SIP_{t-i} + \varepsilon_t \quad (3)$$

where, operator Δ represents the differencing operation.

An ARDL structure of model 2 is expressed in equation 4:

$$\Delta \text{GVACIGDP}_t = \beta_0 + \sum_{k=1}^{m} \beta_1 \Delta\ GVACIGDP_{t-k} + \sum_{k=0}^{n} \beta_2 \Delta GEE_{t-k} + \sum_{k=0}^{p} \beta_3 \Delta RDE_{t-k} \\ + \sum_{k=0}^{q} \beta_4 \Delta ITE_{t-k} + \sum_{k=0}^{r} \beta_5 \Delta IRDC_{t-k} + \gamma_1 GEE_{t-i} + \gamma_2 RDE_{t-i} \\ + \gamma_3 ITE_{t-i} + \gamma_4 IRDC_{t-i} + \varepsilon_t \quad (4)$$

4. EMPIRICAL RESULTS AND DISCUSSION

4. 1. DESCRIPTIVE STATISTICS

The study utilized time series variables as defined in Table 1. In the study, the mean, median, standard deviation, minimum, maximum, asymmetry, and Jarque-Bera statistics for each variable used in our model, and their respective characteristics, are described in Table 2 below. The study validates the variables by mean, median, asymmetry, and minimum and maximum variables.

Table 2. Values of descriptive statistics of the displayed series

Values	GVACI	GVACIGDP	GEE	RDE	ITE	IRDC	VIP	SIP
Mean	340768.90	0.78	3.35	0.17	0.31	57728.97	604855.40	1.33
Median	266392.80	0.74	3.39	0.17	0.13	61672.70	379005.60	1.46
Maximum	954957.10	0.96	4.46	0.28	1.85	121560.10	1879123.00	2.43
Minimum	37568.86	0.64	2.26	0.12	0.03	14579.80	74718.50	0.49
Std. Dev.	271339.70	0.12	0.66	0.05	0.47	29708.42	577222.00	0.48
Skewness	0.72	0.29	0.07	0.68	2.26	0.48	1.00	0.13
Kurtosis	2.44	1.41	2.37	2.22	7.29	2.50	2.73	2.74
Jarque-Bera	1.87	2.29	0.33	1.95	30.74	0.93	3.24	0.10
Probability	0.39	0.32	0.85	0.38	0.00	0.63	0.20	0.95
Sum	6474610.00	14.87	63.69	3.30	5.93	1096850.00	11492253.00	25.22
Sum Sq. Dev.	1.33E+12	0.25	7.87	0.04	4.00	1.59E+10	6.00E+12	4.22
Observations	19	19	19	19	19	19	19	19

Source: Author`s calculation

According to the descriptive statistics, the medians of GVACI and GVACIGDP are 266392.80 tenge and 0.74%, respectively, and standard deviations are 271339.70 and 0.12. The Jarque-Bera statistics are respectively 1.87 and 2.29, while the probabilities of the relationship are 0.39 and 0.32, which is greater than 0.05, so it can be concluded that the series is uniformly distributed. The GEE median is 3.39%, and the standard deviation is 0.66.

The standard deviation for RDE does not exceed 0.05, which indicates the heterogeneity of the indicator in the period under consideration, and the standard deviation for all other indicators exceeds. In Table 2, it can be seen that for all the indicators under consideration, the coefficient of asymmetry of time series is greater than zero, that is, they have a right asymmetry. The value of kurtosis for all indicators suggests that the distribution is almost normal, without excessive kurtosis.

4. 2. UNIT ROOT TEST

Before studying long-term relationships between the series, it is important to determine whether they are stationary. In this study, the Augmented Dickey-Fuller (ADF) unit root tests were used to examine the levels or differences of the variables that are considered stationary. Some variables can be used at the I(0) level, while other variables are stationary at the first difference I(1). In addition, other cointegration methods are sensitive to sample periods. For the purposes of this study, the ARDL can be constructed. Table 4 presents the results of the Augmented Dickey-Fuller (ADF) lag unit root test for the level and first difference series, since the optimal lag is the first step in measuring ARDL models. ADF tests the non-stationary null hypothesis, which is rejected if the ADF is more negative or greater than the absolute critical values of 1%, 5% and 10%. The results indicate that all explanatory variables are stationary at first difference. GVACI is stationary only for the case with Trend and intercept, and GVACIGDP is stationary in the case with Intercept and without Trend and intercept.

Table 3. ADF unit root tests

Variables	Intercept			Trend and intercept			None		
	Level	First diff.	Order of Integration	Level	First diff.	Order of Integration	Level	First diff.	Order of Integration
GVACI	3.694 (1.000)	-2.393 (0.159)	>I(1)	-0.567 (0.965)	-4.231** (0.025)	I(1)	4.457 (0.999)	0.765 (0.867)	>I(1)
GVACIGDP	-0.710 (0.820)	-2.82* (0.076)	I(1)	-2.285 (0.807)	-2.727 (0.239)	>I(1)	1.571 (0.966)	-2.64** (0.012)	I(1)
GEE	-1.178 (0.660)	-4.13*** (0.006)	I(1)	-2.093 (0.688)	-3.985** (0.031)	I(1)	1.206 (0.934)	-3.76** (0.000)	I(1)
RDE	-1.384 (0.567)	-4.84*** (0.002)	I(1)	-2.641 (0.269)	-0.94*** (0.005)	I(1)	-1.570 (0.107)	-4.37*** (0.000)	I(1)
ITE	0.299 (0.971)	-3.027** (0.052)	I(1)	-0.477 (0.974)	-3.419* (0.082)	I(1)	0.928 (0.898)	-2.878*** (0.007)	I(1)
IRDC	1.462 (0.998)	-2.804* (0.079)	I(1)	-0.429 (0.997)	-3.247** (0.019)	I(1)	4.787 (0.100)	-1.656* (0.091)	I(1)
VIP	1.354 (0.998)	-5.14*** (0.001)	I(1)	-1.,472 (0.801)	-6.05*** (0.001)	I(1)	2.700 (0.997)	-4.062*** (0.000)	I(1)
SIP	-1.652 (0.437)	-4.19*** (0.005)	I(1)	-2.209 (0.457)	-3.660* (0.062)	I(1)	-0.239 (0.586)	-4.324*** (0.000)	I(1)
Notes:1) *, **, *** denote statistically significant at the 10%, 5% and 1% levels, respectively p-value is inside brackets									

Source: Author`s calculation

Therefore, these variables are used to evaluate the ARDL models. The unit root results are consistent with the initial assumptions, which requires the use of an ARDL model test to confirm the existence of long-term relationships between the Kazakh creative industry GVA and the explanatory economic factors proposed in the study.

4. 3. GRANGER CAUSALITY TEST

To examine the causal relationship between the selected variables and GVA for the creative industry, a Granger test is performed, testing the null hypothesis that changes in the dependent variable exhibit Noncausality. The acceptance criterion is called the P-value. If P is less than 0.05, the null hypothesis is rejected. According to Table 4, the null hypothesis is not accepted for all variables.

Table 4. Granger noncausality tests for the vector autoregressive (1) model (2004-2022)

Direction of causality	F-statistic	Prob.
GVACI		
GEE does not Granger Cause GVACI	4.353461	0.1134
IRDC does not Granger Cause GVACI	2.562635	0.2777
VIP does not Granger Cause GVACI	0.479421	0.7869
SIP does not Granger Cause GVACI	0.150243	0.9276
GVACIGDP		
GEE does not Granger Cause GVACIGDP	1.864775	0.3936
RDE does not Granger Cause GVACIGDP	0.263134	0.8767
ITE does not Granger Cause GVACIGDP	1.928478	0.3813
IRDC does not Granger Cause GVACIGDP	0.647944	0.7233

Source: Author`s calculation

4. 4. CO-INTEGRATION TEST

The ARDL bounds testing procedure is used in this study to examine the long-term relationship between the selected variables and the GVA for the creative industry of the Republic of Kazakhstan. Before conducting the cointegration test, it is important to determine the lag length criterion. To study the long-term relationship between the variables, the ARDL method was chosen using a small sample size. The lag length criterion is determined based on LR, FPE, AIC, SC and HQ. Table 5 presents the results of the selected lag. As can be seen from Table 6, the selected lag length is 1 since it has more stars and was used throughout the study.

Table 5. Selection order criteria

NARDL (1, 1, 0, 1, 1)						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-681.1663	NA	8.89e+26	76.24070	76.48802	76.27480
1	-602.5485	104.8237*	2.62e+24*	70.28316*	71.76712*	70.48778*
ARDL (1, 1, 0, 1, 1)						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-146.7289	NA	14.43932	16.85877	17.10609	16.89287
1	-68.53169	104.2630*	0.044645*	10.94797*	12.43192*	11.15258*

Source: Authors' analysis results

4. 5. RESULTS OF LONG- AND SHORT-RUN RELATIONSHIP

In the study, the non-linear NARDL model (Equation 3) was estimated using logarithms and the first difference from the ADF test. To conduct long-term and short-term analyses of the relationship between the variables, the results obtained are presented in the following table.

The results of the cointegration F-test for NARDL (Table 6) show that the obtained F-statistic (21.3530) exceeds the upper limit of 5.72 and is statistically significant at the 10% and 5 % significance levels. Similarly, for the linear ARDL model, the F-statistic (4.7877) also exceeds 4.44. The results show that the selected variables are cointegrated and, in the Kazakhstan case, there is a long-term relationship between them.

Table 6. Results of cointegration test

Model	F Statistics	Critical Bounds	Decision
NARDL (1, 1, 0, 1, 1)	21.3530	4.06-5.72	Cointegration
ARDL (1, 1, 0, 1, 1)	4.7877	3.01-4.44	Cointegration
Critical bounds are reported at 1% (***) and 10% (**) level of significance			

Source: Authors' analysis results

Given that the selected variables are cointegrated in the long run, it can be proceeded to the next step, which requires estimating the long-run and short-run coefficients. With NARDL(1, 1, 0, 1, 1) and ARDL(1, 1, 0, 1, 1), the authors can estimate how a change in the explanatory variables affects the dependent variable in both the long and short run.

Table 7. Results of NARDL and ARDL estimation (2004-2022)

Model 1- results of NARDL estimation ΔLOG(GVACI)			Model 2- results of ARDL estimation Δ GVACIGDP		
Variable	Coefficient	t-Statistic (Prob.)	Variable	Coefficient	t-Statistic (Prob.)
Short Run					
@TREND	0.186601***	7.832(0.0001)	GVACIGDP(-1)	-0.548840***	-3.83(0.0033)
LOG(GVACI(-1))	-0.859103***	-9.049(0.0000)	GEE(-1)	*0.030405***	1.878(0.0898)
GEE(-1)	*0.143448****	4.701(0.0015)	RDE**	*0.965751****	3.336(0.0075)
IRDC**	-4.98E-06**	-2.604(0.0314)	ITE(-1)	-0.136402**	-2.564(0.0282)
VIP(-1)	-4.92E-07***	-4.879(0.0012)	IRDC(-1)	*4.59E-06****	3.216(0.0092)
SIP(-1)	*0.124724***	2.961(0.0181)	ΔGEE	-0.073796**	-2.734(0.0210)
ΔGEE	-0.064735*	-2.250(0.0545)	ΔITE	-0.048370	-1.545(0.1533)
ΔVIP	*2.75E-07***	3.038(0.0161)	ΔIRDC	-4.47E-06**	-2.585(0.0272)
ΔSIP	-0.188551***	-3.767(0.0055)			
Long Run					
GEE	*0.166974****	4.356(0.0024)	GEE	*0.055399**	1.918(0.0841)
IRDC	-5.80E-06**	-2.707(0.0268)	RDE	*1.759623****	6.563(0.0001)
VIP	-5.73E-07***	-5.721(0.0004)	ITE	-0.248528***	-4.201(0.0018)
SIP	*0.145180***	2.970(0.0179)	IRDC	*8.35E-06*** *	7.143(0.0000)
Diagnostic	F-statistics	P-value	Diagnostic	F-statistics	P-value
Serial correlation	9.1042	0.1521	Serial correlation	1.3264	0.2920
Heteroskedasticity	0.9917	0.5101	Heteroskedasticity	0.8384	0.5928
Jarque-Bera	3.1003	0.2122	Jarque-Bera	1.2425	0.5373

1) coefficients are statistically significant at ***1%, **5%, *10% level of significance.
2) compiled by the authors
3) positive impact is in italics

Source: Authors' analysis results

In the study, in Kazakhstan, over the long term, IRDC and VIP are negatively correlated with LOG(GVACI), with corresponding coefficients of -5.80E-06 and -5.73E-07, respectively, ceteris paribus (Table 7). The results show that GEE and SIP are positively correlated with ΔLOG(GVACI), with corresponding coefficients of 0.166974 and 0.145180, all other things being equal.

The obtained empirical data (Table 7) show that in Kazakhstan, Internal R&D costs by branches of science (IRDC) also negatively and significantly correlates with ΔLOG(GVACI) in the short term, with a coefficient of -4.98E-06.

In addition, the coefficient of the lagged variable LOG(GVACI(-1)) in period *t-1*, in the short term, turned out to be negative (-0.859103). A positive relationship for the lagged variable Government expenditure on education - GEE(-1) and a negative relationship for the growth in Government expenditure ΔGEE were confirmed (0.143448 and -0.064735, respectively). For the Volume of innovative products (goods, services), the coefficient of the lagged variable VIP(-1) has a negative (-4.92E-07), and with a growth in ΔVIP a positive (2.75E-07) sign. Also, in the short term, the Share of innovative products ΔSIP is negatively and significantly correlated

with LOG(GVACI) with a coefficient of -0.188551.

Table 7 shows the long-term evaluation results of the selected ARDL model. In Kazakhstan, in the long term, only Information technology exports, as a percentage of total goods export (ITE), are negatively correlated with the share of GVA in the creative industry in GDP (ΔGVACIGDP), with a coefficient of -0.248528, *ceteris paribus* (Table 7). The results also show that GEE, RDE and IRDC are positively correlated with ΔGVACIGDP, with the corresponding coefficients of 0.055399, 1.759623 and 8.35E-06, respectively, all other things being equal.

In the short term, Research and development expendture (RDE) is also positively and significantly correlated with ΔGVACIGDP, with a coefficient of 0.965751. Growth in Government expenditure on education ΔGEE and Internal R&D costs by branches of science ΔIRDC have a negative impact (-0.073796 and -4.47E-06, respectively) on the growth of the share of GVA in the short term.

In addition, the negative impact of the lagged variable GVACIGDP(-1) in period *t-1* on the level of ΔGVACIGDP in period *t* in the short term (-0.548840) was proven.

To check the stability of the nonlinear NARDL1 and linear ARDL2 models, diagnostic tests were conducted (Table 7). These include tests for serial correlation, normality and heteroscedasticity. For this model, the null hypothesis of the absence of serial correlation, homoscedasticity and normality cannot be rejected. This indicates that the NARDL1 model is free of serial correlation and heteroscedasticity.

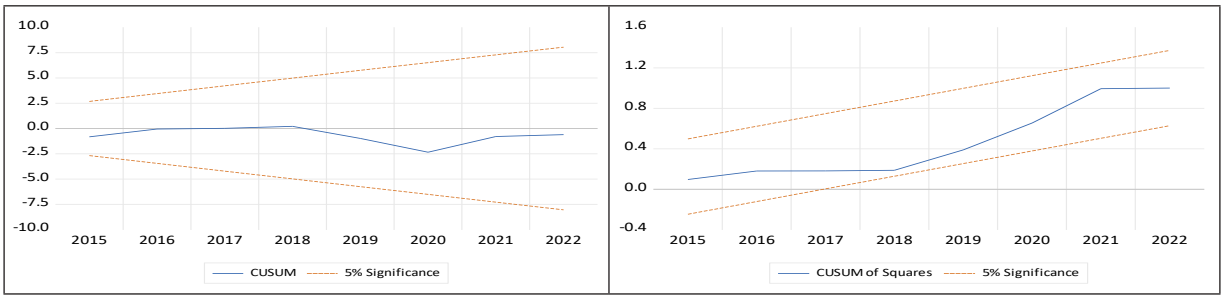
Table 7 presents the results of the diagnostic tests. For the NARDL model, the serial correlation is 9.1042 and the probability value is 0.1521. As a result, the null hypothesis is accepted in this analysis, concluding that there is no serial correlation in the model. The heteroscedasticity tests show that the F-statistic is 0.9917 and the probability is 0.5101, with both values greater than the 0.05% significance level, indicating that the model is homoscedastic. The model accepts the null hypothesis of the normality test and concludes that the residuals are normally distributed, as evidenced by the F-statistic of 3.1003 and the probability value of 0.2122, and both values have a significance level > 5%. Finally, all diagnostic tests for serial correlation with the Langrange multiplier, the Jarque-Bera normality test, and the heteroscedasticity test were successful, indicating the robustness of the NARDL1 model. The robustness of the ARDL2 model is also explained accordingly.

4. 6. STABILITY TESTS

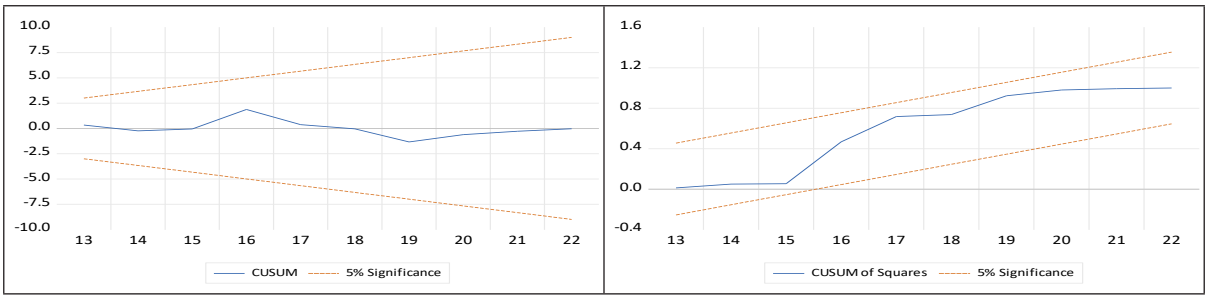
The CUSUM and CUSUM-squared tests are used to test whether the coefficients of the estimated models remain constant over time, which is an indicator of the stability of the model.

Figure 4. CUSUM and CUSUM

Model 1- NARDL



Model 2- results of ARDL



Source: Author`s calculation

The results of the CUSUM and CUSUMSQ robustness tests are presented in Figure 3. At a 5% significance level of the tests, failure to exceed critical thresholds indicates that the model is robust. This test is also used to study the long-term dynamics of regression.

5. RESULTS AND DISCUSSION

Research and development expenditure, as a percentage of GDP (RDE), has a positive effect on the share of GVA for the creative industry in GDP (%), both in the short and long term. The development of the creative economy in countries is influenced by the expenditure on research and development, which affects the increase in creative productivity, the increase in the number of issued international patents, and the steady growth of the number of professionals working in the creative economy as a whole. Therefore, to assess the creative potential of the country, it is very important that, together with other areas of the creative economy, research and development be a priority. In order to obtain new and additional knowledge, solve competitive problems in order to create new products and services, as well as to improve existing ones, state support is important in research and development (Istudor, 2018; Lupu et al., 2025).

The main factor and condition for the development of the creative economy is the Government expenditure on education, total (% of GDP) (GEE), which affects the quality of human capital. In this regard, both models confirm the positive effect of Government expenditure on education in the long term and the positive effect on the creative economy of the lag variable of the previous year, in the short term. However, the growth of Government expenditure on education in the short term has a negative impact, which can be explained by the very small share of spending on education in Kazakhstan and the fact that the results of education in the field of vocational education and high technologies do not appear in a proper way.

Information technology exports (ITE) and Volume of innovative products (VIP) have a negative impact in the long term.

This may be due to the high dependence of the domestic market on foreign goods since imports in creative industries significantly exceed exports. This can be explained by the lack of specialists who produce creative products, the lack of creative infrastructure that helps implement ideas and collaborate with industry representatives, and the underdevelopment of the service sector, which is crucial for the development of creative sectors. Nevertheless, some studies (Kichurchak, 2023; Shkarina, 2024; CEO, 2024) demonstrated the opposite. The authors suggest that the difference in results is based on the differences in economic structures and the diversity of the countries studied. In the short term, the growth of ΔITE and the lag variables, ITE(-1) and VIP(-1), also have a negative impact. However, the growth of Total GVA for the creative industry in the short term is ensured by the growth of Volume of innovative products.

Based on the results of the NARDL model, Internal R&D costs by branches of science (IRDC) have a negative impact on the growth of Total GVA for the creative industry in both the short

and long run. According to the results of the ARDL model, the negative impact of the growth of ΔIRDC on the growth of ΔGVACIGDP in the short run is confirmed. However, IRDC in the long run and the lagged variable IRDC(-1) in the short run have a positive impact on the growth of the share of GVA for the creative industry. The Share of innovative products (SIP) in the short run, and SIP(-1) in the short run, have a positive impact on the growth of ΔLOG(GVACI), although the growth of ΔSIP in the short run has a negative impact. Numerous studies have demonstrated a favorable and significant correlation between economic growth and research and development spending (Goel & Ram, 1994; Ali et al., 2021; Kalin, 2023; Tung & Hoang, 2024; Ahmed et al., 2024). As the growth of the creative economy is also essential to the growth of this sector, it follows that spending on research and development also contributes to the growth of the creative economy.

The mobilization of investment in the creative sectors of the economy increases the commercial sustainability of impact projects. These investments significantly stimulate market development, which enables the creative industry to function effectively despite the unstable income of cultural and creative sectors on a market scale.

6. CONCLUSION

To assess the indicators of innovation, knowledge and digitalization that affect the creative economy, the authors selected the following indicators for the period 2004-2022: Total GVA for the creative industry, share of GVA for the creative industry in GDP, Government expenditure on education, Research and development expenditure, Information technology exports, Internal R&D costs by branches of science, Volume of innovative products (goods, services) and Share of innovative products (goods, services) in GDP. The dependent variables related to the creative economy are: Total GVA for the creative industry and the share of GVA for the creative industry in GDP. To fully determine the linear and nonlinear impact of the indicators on these two dependent variables, ARDL and NARDL models were used for both the short and long run.

The results of the ARDL model are as follows:

The Share of GVA for the creative industry in GDP is impacted negatively by the growth of government expenditure, growth of Internal R&D costs by branches of science, and lag variables of Information technology exports and share of GVA for the creative industry in GDP. In contrast, Research and development expenditure, as well as lag variables of Internal R&D costs by branches of science and Government expenditure on education, have a positive impact in the short run. The Share of GVA for the creative industry in GDP is impacted positively by Government expenditure on education, Research and development expenditure, and Internal R&D costs. However, Information technology exports has a negative impact in the long run.

The results of the NARDL model are as follows:

Total GVA for creative industries is impacted negatively by Internal R&D costs by branches of science, the growth of Government expenditure on education, the growth of Share of innovative products and lag variables of Volume of innovative products, and lag variables of Share of GVA for the creative industry in GDP. Positive impacts in the short run come from the growth of Volume of innovative products and lag variables of Share of innovative products and lag variables of Government expenditure on education. In long run, Total GVA for creative industries is impacted positively by Government expenditure on education and the Share of innovative products, while Internal R&D costs by branches of science and the volume of innovative products have negative impacts. Thus, the results show that the hypotheses were only partially supported: H_0 was confirmed partially, H_1 was not confirmed, and H_2 was confirmed only in the long term.

Some policy implications

The negative impact of the growth in government spending on education in the short term suggests that the return on investment in education is not immediate. However, the fact that creative industries have a positive long-term impact on overall GVA suggests that returns will accrue over time. The negative impact of internal research and development costs by scientific indicators indicates that research and its effectiveness and commercialization opportunities should be prioritized. The negative impact of funds allocated to Research and Development in both the short and long term may be due to the absence of strict state requirements for such research, or a lack of proper government attention to research with practical significance —such as research that results in a new product, an innovative activity or a product that can be patented. For this reason, the share of innovative products and services may have a negative impact. The development of the creative economy should be considered a national strategic advantage rather than limited to entertainment and cultural activities, with scientific research and the quality of its results as the primary priority.

7. RESEARCH LIMITATIONS

Since there is little empirical research on these factors, the authors used the method of deduction to draw specific conclusions from general theoretical ones. Data gathered from a variety of accessible sources was used in the study to support the empirical objectives. Since Kazakhstan lacks data on many factors, these data, which are time series by year, span the years 2004–2022. It should be mentioned that the study is particularly significant because the data spans recent years, and diagnostic tests show that the model is appropriate. The authors lacked access to extensive data spanning multiple decades as the creative economy is still a relatively new area of study. The authors sought to show that the creative economy includes more than just leisure and cultural events. Since science, technology, and knowledge are interrelated and interdependent, the researchers contend that nations must advance these three pillars to foster a creative economy in the long run. The authors hope that this article will become a starting point for other researchers.

8. DECLARATIONS

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Competing Interests

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