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MANAGEMENT OF INTERNATIONAL TRADE IN THE CONTEXT OF ENSURING INNOVATIVE DEVELOPMENT

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Abstract: *The activities of companies in the foreign market that offer their products and services face several unique challenges, domestic and international, global competition, and additional requirements at several levels. Therefore, developing best practices and considering the evolution of trading processes, strategies, regulations, and technological innovations are mandatory for continuity and prosperity in the international market. The article carries out a bibliometric analysis of publications by keywords «international trade» and «innovations» in the system of international commodity-monetary relations in the conditions of innovative processes and prospects of international exchange of scientific and technical knowledge and technologies. The article aims to investigate the functional link between international trade and the level of the country's innovative development and confirm the hypothesis about the significance of this link. The following methodological tools were used in the article: Canonical Correlation Analysis and Multivariate Panel Data Regression Model. Forty-four European and Asian countries are investigated. The period of the investigation is from 2006 to 2021. The array of input variables includes a set of indicators, six of which characterize the innovative development of the studied countries; five indicators represent international trade; and three indicators control and describe the socio-economic development of nations. The revealed correlation-regression dependences generally provide a basis for confirming the hypothesis of a direct relationship between the country's innovative development level and its positioning in the field of international trade. The obtained results proved the presence of a direct statistically significant relationship between High technology exports, Import and Current account balance; Innovation index and External balance on goods and services. An inverse functional dependence was found between the indicator Patent applications by residents and the Current account balance. In the future, it is necessary to adapt the proposed methodology to develop a functional basis for the analysis of the impact of innovations on the ecosystem of specific enterprises; to consider the national aspects of conducting business, and the state policy implication of supporting the digitization of crucial stages of production.*
Keywords: innovations, international trade, management of international trade, innovative development, Canonical Analysis, panel regression.
JEL Classification: L91, R40

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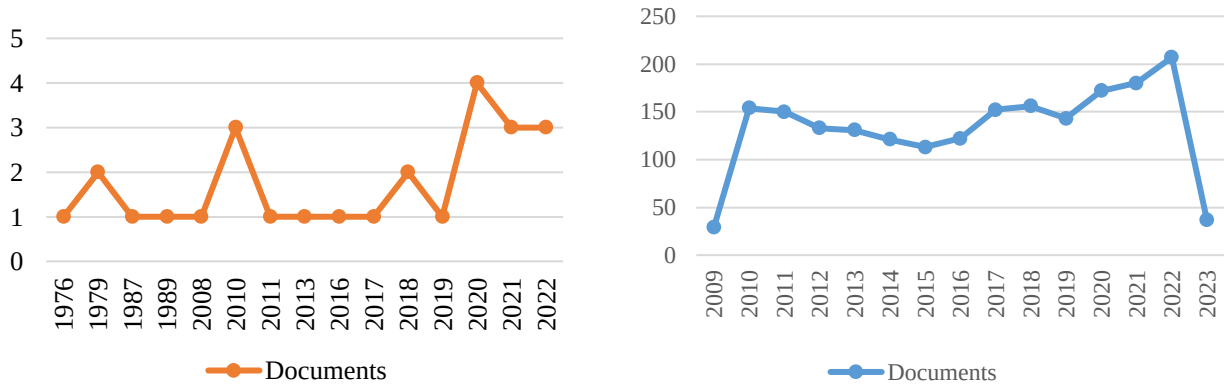
Introduction. The development of the modern global world has gained significant technological progress in the 21st century. This period was marked by the transition to the knowledge economy (digitalization of society). It determines the specifics of the development of cities, regions, etc. Informatization of community causes radical changes that provoke the formation of the economies of developed countries and exerts a significant influence on the sphere of international trade. Nowadays, the globalization processes have taken an important role. International trade is a key factor in profitability and a way of doing business. It stimulates the development of innovations. With innovative technologies, it is possible to consider the acceleration of humanity's economic, scientific, and technical development. However, this factor can also provoke other competition between business entities. That is why the globalization revolution creates the interpenetration and merger of the economies of different countries. In these conditions, a number of rules must be followed. Requirements and procedures in the field of international trade are constantly changing, so it is necessary to be aware of these changes in order to avoid delays in both production and distribution of goods. International trade is a complex process, so it is important for exporting companies to consider innovative best practices and take advantage of lower logistics costs to achieve greater market share and succeed in opening new markets.

Literature Review. The relevance of the direction of management of international trade in the context of ensuring innovative development is confirmed by the growing interest of the international scientific community in this issue, which is reflected in the positive dynamics of the number of relevant publications in the international databases Scopus and WoS (Figure 1).



(a) (b)

Figure 1. The dynamics of scientific publications (keywords «innovations» and «international trade») presented in the databases WoS (a) and Scopus (b)

Source: developed by the authors based on the results of Scopus and WoS database.

As can be seen from these figures, innovation and international trade publications are published more in the Scopus database in absolute terms. Most publications are from scientists from China, the USA, and the United Kingdom (Figure 2).

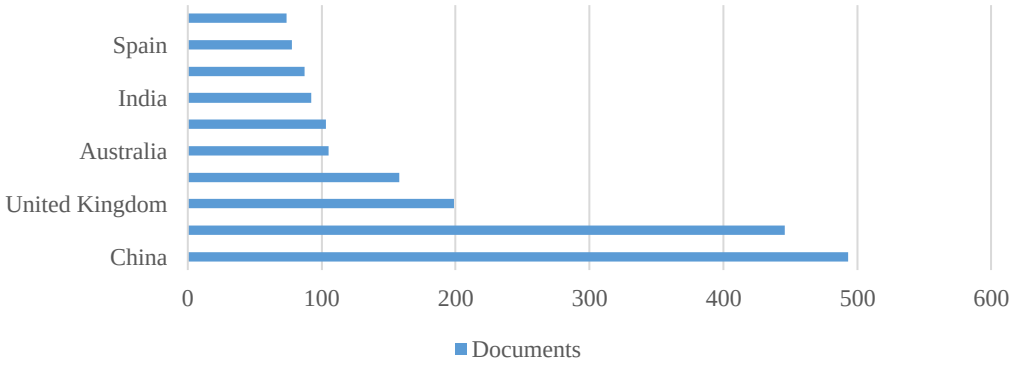


Figure 2. Scientific publications in the leading countries by the keywords «innovations» and «international trade» presented in the Scopus

Source: delevoped by the author based on the results of Scopus.

According to queries for the keywords «innovations» and «international trade» presented in the Scopus scientometric database, scientific publications are distributed as follows (Figure 3).

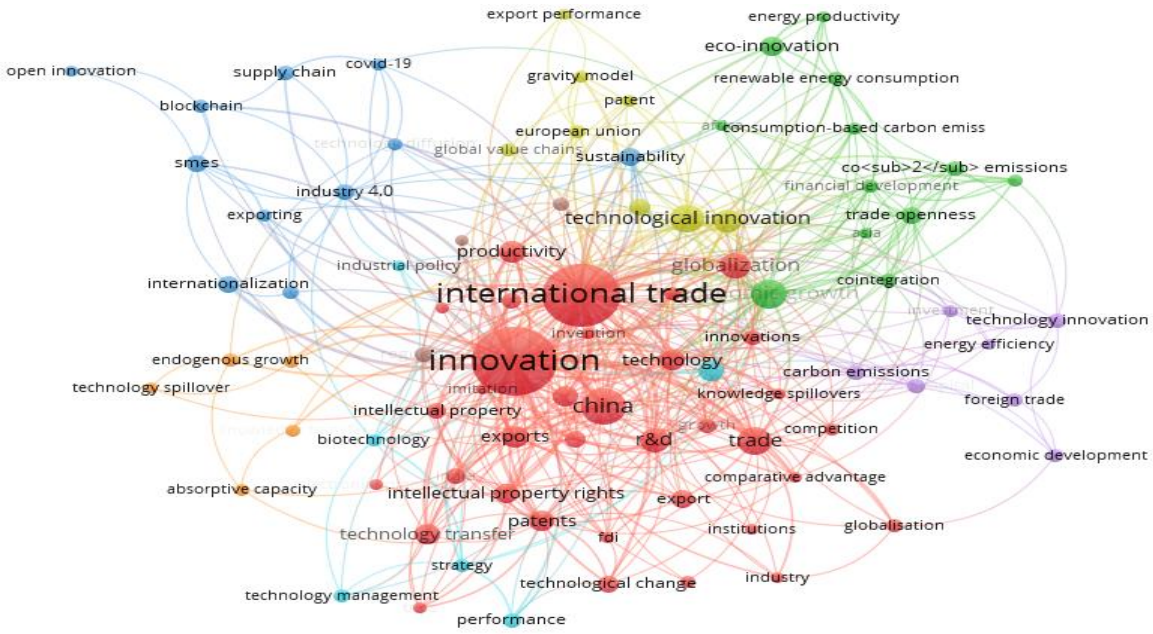


Figure 3. Distribution of scientific publications by thematic groups according to the keywords «innovations» and «international trade» presented in the Scopus

Sources: built by the author based on the results of Scopus.

Given the close placement of keywords and connecting lines between them, five main thematic groups of publications related to the concepts of «innovations» and «international trade» could be identified:

- related to globalization processes,
- investments, and human capital;
- trade openness and energy security;
- technological penetration, COVID-19 and the concept of «industry 4.0»;
- an international corporation;
- from the concept of Global Value Chain.

In this context, it is worth paying attention to the most interesting results of scientists that have been published in recent years. Thus, in the work of a group of scientists led by Amaral et al. (2023) examine the importance of industrial capabilities in Spain and Portugal during the crisis caused by the spread of the COVID-19 pandemic. In particular, the authors emphasize the high demand for the production of ventilators. Countries, for which the production of these devices is atypical, had not only to establish their production but also to establish interaction with other international contractors to form a complete set. The authors also propose a new theory on how countries can identify core features to enhance the dynamic stages in areas critical to their social well-being. The impact of COVID-19 on the reformatting of emphases in the conduct of international trade is also reflected in the works of Wu et al. (2022)

The essence of the connection between international trade and countries' financial development level is revealed in a scientific article by Choi (2023). On the example of companies of various levels that conduct their activities in Taiwan, a study was conducted on how much the level of the country's financial development affects the production capacity of companies operating in the foreign market. Gaps in quality and exports between more and less productive exporting companies were found to widen as a country's financial system improved. Blockchain and cryptocurrency are promising directions for modernizing the international trade process. Tandra and Suroso (2022) propose a payment system (stablecoin) for international trade that can operate without the supervision of banks. The influence of electronic commerce systems on international trade processes is considered by Wang et al. (2021). Siddik et al. (2021) studied the connection between blockchain technology and international trade.

Since the world today is a network of closely intertwined trade relations between various companies, there are a lot of articles about the structure and changes in the Global Value Chain (GVC). Ito et al. (2023) investigated how the country's positioning in the sales chain affects the innovative activity of the company.

Japan, as a key participant in Asian value chains during 1995-2011, found itself on the periphery, yielding to several companies operating in China. The Japanese companies involved in patent activities participated in this study. The analysis results show that increasing the central role of Japanese sectors, that is, as key suppliers, is positively associated with increased patent applications by companies in these sectors. Thus, firms benefit from downstream markets. A similar study only for the USA was also conducted by a group of scientists, Zhou et al. (2023), for France – De Rassenfosse et al. (2022), for the group of countries of the European Patent Office - Ye et al. (2022), for Germany – Chen et al. (2021).

Studying the connection between the country's innovative development and its eco-orientation and international positioning within this direction is also one of today's urgent problems. The work of Chen et al. (2022) empirically investigates the influence of the flow of innovative technologies on the eco-efficiency of a country through decomposed diversified channels of flow. The obtained results demonstrate that technologies related to imports positively affect the environmental efficiency of the country's manufacturing industries. The question of the influence of eco-innovation and financial inclusion according to the stable development of international trade is the topic of research in the scientific work of Ma et al. (2022). In the work of Meng et al. (2022) estimated the impact of trade, green innovations, and renewable energy.

New technologies are changing the supply and demand of international trade. The final consumer of goods increasingly affects the work of companies, forcing them to adapt to their needs in all categories - from design and sales market to delivery methods. K. Schwab (2015) identified four main effects that the fourth industrial revolution could have on business. It is a rise in expectations for customers, product quality improvement, joint innovation, and new forms of organizations. All these innovations will soon completely change how people live and will also affect consciousness (that is, gradually alter the very nature of man). People will have free time not only through robotics but also through buying and delivering goods. It will be possible to order individual designs and assembly of products and services, they will be paid instantly, and the drones will deliver the goods directly to the buyer's location. Many markets will work now, bypassing various intermediary structures: brokers and dealers. The need for cheap unskilled labor will gradually disappear, forcing people to live longer thanks to the complete automation of treatment and health care processes.

In the era of globalization of society, food security is one of the research priorities. Schram and Townsend (2021) are the authors of a study of issues that arise at the intersection of international trade, investment, and food systems. The interaction between these constituent parts should primarily solve the problems of food systems arising under the influence of various factors. At this time, policy efforts must be directed at preparing the future of investment and trade systems to create a food system that contributes to the health of people and the planet.

Innovation in conducting international trade is also manifested through creating appropriate software solutions that allow the automation of some processes. European scientists led by Polanec et al. (2022) presented the development of an approach to determine the marginal value of the development of international trade, production, innovation, use of ICT by enterprises, etc. For this, the coverage ratio was used to measure the analytical solutions provided to determine the boundary limits. Based on the results of surveys of enterprises operating in the EU, an appendix was developed that illustrates the approach to determining the limits. Thus, an important practical consequence is an ability to set industry restrictions. In addition, the role of innovative technologies, including international trade, is considered in the works of Klevenhusen et al. (2021) and Ben Hassine and Mathieu (2021). An article by Shadikhodjaev (2021) examines the regulation of trade-as-a-service, intellectual property, and paperless trade. It concludes that the principle of technology neutrality should be universally accepted, complemented by policy flexibility where appropriate. The problem of establishing management of international trade in the context of ensuring innovative development is not sufficiently studied.

It predetermines ***the following research objective*** to test the hypothesis regarding the direct relationship between the country's innovative development and its positioning in international trade.

Methodology and research methods. In order to test the proposed hypothesis, the research is conducted in two steps. In the first step, a canonical analysis is carried out, determining the relationship between two sets of features that characterize the corresponding object. Among the advantages of this method, it is possible to highlight the possibility of determining the influence of several factors on several indicators.

The canonical analysis is one of the regression methods. With the help of the correlation coefficient r (1), the determination coefficient R^2, and the regression coefficient are key indicators of regression analysis. Canonical analysis of variables captures the relationship between a group of predictors with criterion variables.

$$r = \frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2 \sum(y_i-\bar{y})^2}}, \quad (1)$$

Pairwise correlation coefficients are used to determine the linear relationship between two features x and y. When it is necessary to detect dependencies between indicators x_0 and $x_1 \dots x_n$, then a multiple correlation coefficient is used as a characteristic of this dependence, corresponding to the correlation coefficient $R(X_0, \widehat{X_0})$, where $\widehat{X_0} = \beta_0 + X_p^* \beta_p$ is the best linear prediction X_0.

The task of canonical analysis is to find the following normalized linear combinations (2-3).

$$U_1 = \beta_{10} + \beta_{11} X_1 + \cdots + \beta_{1r} X_r \quad (2)$$

$$V_1 = \propto_{10} + \propto_{11} X_{r+1} + \cdots + \propto_{1s} X_{r+s} \quad (3)$$

Thus, it is necessary that the canonical correlation $R=cor(U_1, V_1)$ was maximal (the weighting coefficients were maximal).

In the second step of the study, a multivariate panel regression model is built, which will allow formalizing the functional dependencies between the studied variables. Panel data are rolling spatial datasets where each object appears multiple times (monthly, quarterly, annually, etc.) over a selected period. The use of data in this format opens up several prospects for developing economic science. Panel data allow for considering the heterogeneity of the economic entities participating in the study. In addition, using panel data in the analysis has several other advantages:

– allow analyzing a set of economic issues that cannot be expressed through time series or spatial data;
– prevent a shift in data aggregation that may occur during the analysis of time series and cross-sectional data, where unobserved individual characteristics of objects are not taken into account, where heterogeneity of data is not taken into account);
– enable the researcher to analyze a larger number of observations, which increases the set of freedom degrees and reduces the dependence between explanatory parameters and the probability of the appearance of standard errors of estimates;
– make it possible to avoid specification errors that arise from neglecting some types of existing variables in the modeling.

Given the listed advantages of using panel data, one of their weaknesses is that self-bias may be present. If this happens for random reasons, then the self-selection bias may not occur.

The formalized form of the multivariate regression model has the following form (4)

$$y_{it} = \alpha + X_{it}^* \beta + \nu_{it}, i = 1, \dots, N; t = 1, \dots, T, \quad (4)$$

where i – serial number; t – period of investigation; α- constant term; β- vector of dimension coefficients K×1; X_{it}^* - row vector of the matrix K of explanatory variables; ν_{it} - error of the regression.

$$\nu_{it} = u_i + \varepsilon_{it} \quad (5)$$

where u_i- individual effects of variables; ε_{it}- residuals of the model.

When studying panel data, two main models could be constructed: models with fixed and random effects. Each independent variable is non-random in models with fixed effects (they uniquely influence the dependent variable). In this time, in the model with random effects, the moment of randomness is not excluded, which manifests itself in the selection of research indicators. That model is better suited for the selected data set and allows for solving one of the special tests (Wald, Breusch-Pagan or Hausman) (Kolenikov, 2001).

Before proceeding to the canonical analysis, it is necessary to form an array of input data. In this case, their role would be played by sixteen indicators from the relevant databases of the World Bank: six that identify the level of innovative development of countries (I_S1-I_S6), seven indicators characterizing international trade (I_T1-I_T6) and three indicators of macroeconomic development (G1-G3):

– Innovation index (I_S1);
– Research and development expenditure, % of GDP (I_S2);
– Information technology exports, % of total goods exports (I_S3);

- High technology exports, US dol (I_S4);
- High tech exports, % of manufactured exports (I_S5);
- Patent applications by residents (I_S6);
- Import, US bln dol (I_T1);
- Export, bln US dol (I_T2);
- Trade openness: exports plus imports as % of GDP (I_T3);
- Current account balance as % of GDP (I_T4);
- Current account balance, billion USD (I_T5);
- External balance on goods and services, % of GDP (I_T6);
- External balance on goods and services, USD (I_T7);
- GDP per capita, current U.S. dollars (G1);
- Inflation, consumer prices, annual % (G2);
- Real interest rate: Bank lending rate minus inflation (G3).

The canonical analysis is used to study the influence of indicators of innovative development (I_S1-I_S6) on key indicators of international trade (I_T1-I_T6) using annual statistical data of 44 studied countries of Europe and Asia (Albania, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungry, Iceland, Ireland, Italy, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Luxembourg, Moldova, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Tajikistan, Turkiye, Turkmenistan, Ukraine, United Kingdom, and Uzbekistan) during 2002–2021

The canonical function (6) was used for the study.

$$У = f(x), \quad (6)$$

where x – canonical variables for the characteristics of innovative development; У – canonical variables to characterize international trade; $X = a_0 + a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 + a_5x_5 + a_6x_6$; x_1 – Innovation index (I_S1); x_2 – Research and development expenditure (I_S2); x_3 – Information technology exports (I_S3); x_4 – High technology exports (I_S4); x_5 – High tech exports (I_S5); x_6 – Patent applications by residents (I_S6).

$$У = b_0 + b_1y_1 + b_2y_2 + b_3y_3 + b_4y_4 + b_5y_5 + b_6y_6 + b_7y_7 \quad (7)$$

where y_1 – Import (I_T1); y_2 – Export (I_T2); y_3 – Trade openness (I_T3); y_4 – Current account balance as % of GDP (I_T4); y_5 – Current account balance, billion USD (I_T5); y_6 – External balance on good and services, % of GDP (I_T6); y_7 – External balance on goods and services, billion USD (I_T7).

Results. The Canonical Analysis module of the STATISTICA 12 was used. The canonical correlation coefficient R is 0,98 (Table 1). It indicates a high level. The Chi-Square indicator of 1514,253 $p < 0,05$ confirms that R is statistically significant.

Table 1. Canonical Analysis Results

	Left Set	Right Set
Number of variables	6	7
Variance extracted	100%	99,1%
Total redundancy	50,4%	52,2%
Chi-Square	1514,253	
R^2	0,98	

Sources: developed by the authors.

According to Table 1, 100% of innovation development indicators are considered (Left Set), and 99,125%t of international trade indicators (Right Set). The Total redundancy indicator means that the variation in the Left Set innovation development indicators explains more than 52,29% of the variation in international trade indicators. The closeness of the relationship between the groups of studied indicators is also confirmed graphically (Figure 4).

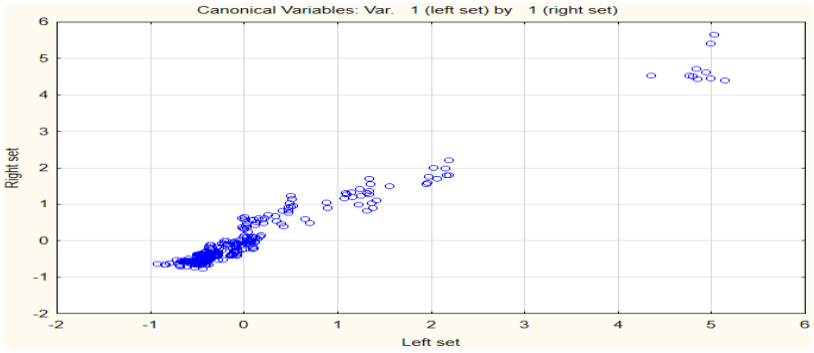


Figure 4. Scatter diagram of canonical variables of the studied groups of indicators of innovative development of countries and the level of international trade

Sources: developed by the authors.

Since the smaller set, which includes the indicators of innovative development, consists of six indicators, the system identified six canonical roots in general. Figure 5 confirms this, where the graph of the Eigenvalues of the selected six canonical roots is presented.

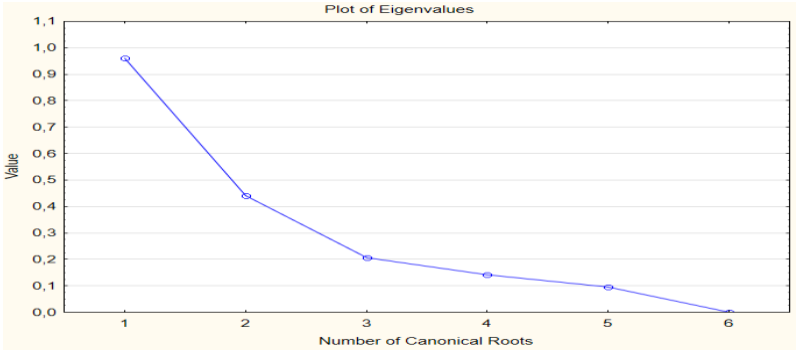


Figure 5. Plot of Eigenvalues

Sources: developed by the authors.

The p values of the Chi-Square test show that the roots 0-4 are statistically significant, the canonical root 0 shows 98,056% of the variance, and root 1 - only 66,428%. Thus, it is necessary to consider only the canonical root 0 (Table 2) for further calculations.

The following figure (Table 3) shows correlation coefficients between groups of variables. The most strong correlation (correlation coefficient greater than 0.5) is observed between the following indicators:

– High technology exports (I_S4) and the following indicators of international trade – Import (I_T1) (correlation coefficient 0,95); Export (I_T2) (correlation coefficient 0,96); Current account balance (I_T5) (correlation coefficient 0,63); External balance on good and services (I_T7) (correlation coefficient 0,68);

– Patent applications by residents (I_S6) and the following indicators of international trade – Import (I_T1) (correlation coefficient 0,88); Export (I_T2) (correlation coefficient 0,9); Current account balance (I_T5) (correlation coefficient 0,67); External balance on good and services (I_T7) (correlation coefficient 0,69).

Table 2. Statistical characteristics of selected canonical roots

Root Removed	Canonical R	Canonical R^2	Chi-Square	df	p	Lambda Prime
0	0,98	0,96	1514,25	42,00	0,00	0,01
1	0,66	0,44	374,20	30,00	0,00	0,34
2	0,46	0,21	170,47	20,00	0,00	0,61
3	0,38	0,14	89,16	12,00	0,00	0,78
4	0,31	0,10	35,81	6,00	0,00	0,90
5	0,03	0,00	0,28	2,00	0,87	1,00

Sources: developed by the authors.

Table 3. Correlation matrix of the studied indicator groups

Root Removed	I_T1	I_T2	I_T3	I_T4	I_T5	I_T6	I_T7
I_S1	0,49	0,49	0,18	0,47	0,24	0,47	0,34
I_S2	0,49	0,49	-0,02	0,48	0,34	0,35	0,36
I_S3	0,09	0,10	0,35	0,15	0,05	0,26	0,11
I_S4	0,95	0,96	-0,11	0,27	0,63	0,16	0,68
I_S5	0,32	0,32	0,01	0,30	0,09	0,31	0,18
I_S6	0,88	0,90	-0,22	0,19	0,67	0,08	0,69

Sources: developed by the authors.

The first root plays a key role in this study. The canonical weights were used of the first root (Tables 4, 5) to build the corresponding canonical variables 8, 9.

Table 4. Canonical weights of the group of innovative development indicators

Variable	Root 1	Root 2	Root 3	Root 4	Root 5	Root 6
I_S1	0,06	1,24	0,16	-1,07	-0,17	-1,10
I_S2	0,05	-0,84	-0,99	1,15	0,64	0,36
I_S3	-0,05	0,20	0,21	-0,27	0,92	0,50
I_S4	0,79	1,03	1,32	2,26	-0,95	0,31
I_S5	-0,11	-0,18	-0,68	-0,49	-0,59	0,75
I_S6	0,21	-1,20	-0,75	-2,28	0,83	-0,24

Sources: developed by the authors.

Table 5. Canonical weights of the group of indicators of international trade

Variable	Root 1	Root 2	Root 3	Root 4	Root 5	Root 6
I_T1	18341,2	-83645,1	-36211,8	-170039	106708	92991
I_T2	-20081,3	91585,8	39649,5	186182	-116838	-101817
I_T3	0,0	0,8	0,6	0	1	0
I_T4	0,0	0,6	-0,6	1	0	-1
I_T5	0,5	-1,6	-0,2	1	2	1
I_T6	0,0	-0,4	-0,6	-1	0	1
I_T7	2670,8	-12181,1	-5273,5	-24766	15539	13541

Sources: developed by the authors.

$$X = 0{,}06x_1 + 0{,}05x_2 - 0{,}05x_3 + 0{,}79x_4 - 0{,}11x_5 + 0{,}21x_6 \quad (8)$$

$$У = 18341{,}2y_1 - 20081{,}3y_2 + 0{,}003y_3 - 0{,}005y_4 + 0{,}5y_5 - 0{,}0012y_6 + 2670{,}8y_7 \quad (9)$$

The next step of the investigation involves the construction of a multivariate panel regression. For this, STATA 12 was used. Taking into account the results of the canonical analysis to test the hypothesis regarding the presence of a functional dependence between the country's innovative development and international trade, three indicators of innovative development of the studied countries will act as independent variables (Innovation index (I_S1), High technology exports (I_S4), Patent applications by residents (I_S6)) and three control variables (G1-G3). The role of dependent variables would be performed by three indicators of international trade - Import (I_T1), Current account balance, billion USD (I_T5), External balance on goods and services, USD (I_T7). The Export indicator (I_T2) was excluded from considering dependent variables. That is due to the presence among the independent variables of the indicator High technology exports (I_S4), which is directly correlated with this indicator. In this way, three multivariate regression equations (10-12) would be constructed.

$$I\_T_1 = \alpha_0 + \alpha_1 I\_S_1 + \alpha_2 I\_S_2 + \alpha_3 I\_S_3 + \alpha_4 G_1 + \alpha_5 G_2 + \alpha_6 G_3 \quad (10)$$

$$I\_T_5 = \alpha_0 + \alpha_1 I\_S_1 + \alpha_2 I\_S_2 + \alpha_3 I\_S_3 + \alpha_4 G_1 + \alpha_5 G_2 + \alpha_6 G_3 \quad (11)$$

$$I\_T_7 = \alpha_0 + \alpha_1 I\_S_1 + \alpha_2 I\_S_2 + \alpha_3 I\_S_3 + \alpha_4 G_1 + \alpha_5 G_2 + \alpha_6 G_3 \quad (12)$$

To choose the type of panel regression (with random or fixed effects), the Hausman test was used. The condition for its use is that if the p-value of this criterion is less than 0,05, it is necessary to build a regression model with fixed effects; otherwise, it with random effects. Table 6 presents the results of the Hausman test.

Table 6. Hausman test results

Model (dependent variable)	Hausman test	p-value	Type of panel regression
I_T1	202,506	0,0000	With fixed effects
I_T5	11,34	0,0784	With random effects
I_T7	26,98	0,0001	With fixed effects

Sources: developed by the authors.

Thus, the study will construct two-panel regression models with fixed effects and one model with random effects. Table 7-9 presents the results of the regression models.

Table 7. Results of the first model with the dependent variable I_T1

Variables	Reg. coef.	t-stat	p-level
I_S1	-154,8	-0,2	0,841
I_S4	1412,439	3,73	0,000
I_S6	-6,492	-1,64	0,103
G1	1,199	3,65	0,000
G2	23,196	0,07	0,945
G3	-108,365	-0,28	0,779
_cons	127361	3,66	0,000
	R^2=0,75		
	F=5,96 at p=0,0000		

Sources: developed by the authors.

Table 8. Results of the second model with the dependent variable I_T5

Variables	Reg. coef.	t-stat	p-level
I_S1	169,646	0,39	0,698
I_S4	474,016	2,15	0,031
I_S6	-6,979	-4,27	0,000
G1	0,436	2,30	0,022
G2	-14,257	-0,06	0,954
G3	-255,273	-0,89	0,373
_cons	-8060,126	-0,48	0,635
	R^2=0,77		
	χ^2=29,85 at p=0,0000		

Sources: developed by the authors.

Table 9. Results of the third model with the dependent variable I_T7

Variables	Reg. coef.	t-stat	p-level
I_S1	152,001	3,70	0,000
I_S4	-8,361	-0,41	0,679
I_S6	-0,302	-1,43	0,154
G1	0,083	4,76	0,000
G2	-24,173	-1,34	0,180
G3	-40,617	-1,98	0,050
_cons	-6865,562	3,70	0,000
	R^2=0,81		
	F=7,28 at p=0,0000		

Sources: developed by the authors.

The obtained results of regression modeling make it possible to construct the corresponding three regression equations (13-15).

$$I\_T_1 = 127361 - 154{,}8I_{S_1} + 1412{,}439I_{S_4} - 6{,}492I_{S_6} + 1{,}199G_1 + 23{,}196G_2 - 108{,}365G_3 \qquad (13)$$

$$I\_T_5 = -8060{,}126 + 169{,}646I_{S_1} + 474{,}016I_{S_4} - 6{,}979I_{S_6} + 0{,}436G_1 - 14{,}257G_2 - 255{,}273G_3 \quad (14)$$

$$I\_T_7 = -6865{,}562 + 152{,}001I_{S_1} - 8{,}361I_{S_4} - 0{,}302I_{S_6} + 0{,}083G_1 - 24{,}173G_2 - 40{,}617G_3 \quad (15)$$

The obtained criteria values F and χ^2, as well as the corresponding p-value, all three constructed models are statistically significant. The quality of the built models is also confirmed by the obtained coefficients of determination R^2, which for all models show a good result (more than 70% of the dependent variables variation is due to the change of the independent variables involved in the study). Thus, the simulation results are reliable and can be used to make predictions. Statistically significant relationships (p-value – less than 0,05) are observed between the following variables:

– High technology exports (I_S4) and Import (I_T1) – with an increase in I_S4 per unit, I_T1 by 1412,439 bln USD;

– High technology exports (I_S4) and Current account balance (I_T5) – with an increase in I_S4 by one unit, I_T5 will increase by 474,016 bln USD;

– Patent applications by residents (I_S6) and Current account balance (I_T5) – with an increase in I_S6 by one unit, I_T5 will decrease by 6,979 bln USD;

– Innovation index (I_S1) and External balance on goods and services, billion USD (I_T7) – with an increase I_S1 by one unit, I_T7 will increase by 152,001 bln USD.

Conclusions. Despite the difficulties and obstacles, international trade has continued to work effectively in time and after the COVID-19 pandemic. At the same time, the pessimistic forecasts of experts were never realized. The positive factors that restrained the rapid decline of international trade and the world economy are the rapid adoption of the new "rules of the game" by all participants in remaining international commodity markets. A contribution to the investigation of the role of innovation in international trade was made by Silva et al. (2022). A group of scientists investigated the relationship between innovative products and the export performance of small and medium-sized companies. The results obtained in this article are applied during the formation of enterprises' business strategies. However, the drawback is that the accepted recommendations can be used only at the micro level, unlike the results in this article. A study by Huang (2022) investigated the correlation between international trade and innovations in private companies. Unlike this research, the author allows identifying the functional influence of the determinants of international trade. Considering the obtained conclusions, this can be the basis for further research.

A complex econometric model was built following the article's purpose to confirm the hypothesis regarding the direct dependence between the country's innovative development and their positioning in the field of international trade. The object of the investigation is forty-four European and Asian countries were selected from 2006 to 2021. At the first stage of the study, a Canonical Correlation Analysis was built between a group of indicators that characterize innovative development and the level of development of international trade of the countries under study. It was determined that the variation in indicators of innovative development explains more than 52% of the variation in international trade indicators. The strongest correlation is observed between the following indicators: High technology exports and the following indicators of international trade – Import, Export, Current account balance, External balance on goods and services; Patent applications by residents and the following indicators of international trade – Import; Export; Current account balance; External balance on good and services. In the second stage, a Multivariate Panel Data Regression Model was built. The obtained results proved the presence of a direct statistically significant relationship between High technology exports, Imports and Current account balance; Innovation index and External balance on goods and services. An inverse functional dependence was found between the indicator Patent applications by residents and the Current account balance. Thus, the identified correlation-regression dependencies generally provide a basis for confirming the hypothesis of a direct relationship between the country's innovative development and its positioning in the field of international trade.

Thus, considering the obtained results, they are limited by only the macro level. In future investigations, it is necessary to adapt the proposed methodology to develop a functional basis for the analysis of the impact of innovations on the ecosystem of specific enterprises. It is necessary to consider the national aspects of conducting business and the state policy implication of supporting the digitization of crucial stages of production. In this way, it will be possible to form conglomerations of companies according to the level of their informatization within the country. This aspect will make it possible to identify potential business clusters that will contribute to the development of international trade.

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Управління міжнародною торгівлею в контексті забезпечення інноваційного розвитку

Перед компаніями, які пропонують свої продукти та послуги на зовнішньому ринку, постає низка унікальних внутрішніх та міжнародних викликів, глобальна конкуренція та додаткові вимоги. Розвиток найкращих практик і врахування еволюції торговельних процесів, стратегій, правил, а також технологічних інновацій є обов'язковими для безперервності та процвітання на міжнародному ринку. У статті узагальнено аргументи та контраргументи в рамках наукової дискусії щодо місця та перспектив системи міжнародних товарно-валютних відносин в умовах інноваційних процесів та перспектив міжнародного обміну науково-технічними знаннями та технологіями. Основною метою дослідження є підтвердження гіпотези про присутність функціональних зв'язків між міжнародною торгівлею та рівнем інноваційного розвитку країни відповідно до національних особливостей. Методичним інструментарієм дослідження є методи канонічного кореляційного аналізу та множинного панельного регресійного моделювання, що дозволили формалізувати як явні, так і латентні зв'язки між досліджуваними об'єктами. Об'єктом дослідження є дані 44 країн Європи та Азії за період з 2006 по 2021 рр.. У зв'язку з цим масив вхідних даних подано у вигляді незалежних змінних (регресорів), які ідентифікують рівень інноваційного розвитку країн, та залежних змінних (регресантів), які вказують на динаміку міжнародної торгівлі, ведення бізнесу, загальних внутрішніх економічних умов. Крім того, змінні з кожного визначеного блоку було застосовано під час побудови канонічної кореляційної моделі. Виявлені кореляційно-регресійні залежності в цілому дають підстави підтвердити гіпотезу про прямий зв'язок між рівнем інноваційного розвитку країни та її позиціюванням у сфері міжнародної торгівлі. Емпірично обґрунтовано обернену функціональну залежність між індикатором заявок на патенти резидентами та балансом поточного рахунку. У майбутніх дослідженнях методологію для розробки функціональної бази для аналізу впливу інновацій на екосистему конкретних підприємств необхідно адаптувати враховуючи національні аспекти бізнес-середовища та державну політику щодо підтримки цифровізації етапів виробництва.

Ключові слова: інновації, міжнародна торгівля, управління міжнародною торгівлею, інноваційний розвиток, канонічний аналіз, панельна регресія.