Statistical Modeling of Determinants Influencing Economic Security in the Context of Sustainable Development and National Security

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Abstract: The aggravation of the political crisis and the increase in geopolitical conflicts destabilize the world economy and create serious challenges for the national security of all countries of the world. Today, a new theoretical and methodological approach to understanding economic security, which is an important dimension of national security, is needed. Our research uses an approach using multivariate statistical modeling based on a unique set of generally recognized macroeconomic indicators for the year 2022 in most countries of the world. We created a factor model for detections of determinants of influence on national economic security and a model of canonical correlations for evaluating complex two-way relationships between selected determinants and generally recognized reliable indices that can serve as approximate estimates of the level of economic security in the context of the concept of sustainable development (Human Development Index) and national security (GPI – Global Peace Index). The obtained results are not without flaws and are only approximate estimates. However, they can improve the understanding of the problems of strengthening international coordination and cooperation in strengthening economic security, ensuring sustainable development and implementing the tasks of national security strategies of various states of the world.

1 INTRODUCTION

Geopolitical competition has changed the world economy and complicated national security issues. Today, there are no unified methodological approaches to defining the concepts of economic security, national security and their determinants [1]. However, the economic component is present in all proposed systems of national security indicators [2–4]. It is generally recognized that economic security is closely related to both national and global security [5]. Economic security is an important dimension of national security. This is one of the defining strategic priorities for many states of the world.

Economic leverage is often used as a weapon in international conflicts and for political purposes. Ensuring economic security today is one of the mandatory requirements not only for sustainable development but also for the survival of the nation. This is one of the basic aspects of understanding national security [6], solving modern global challenges [7] and ensuring the goals of sustainable development [8]. Economic security is defined as the country's ability to resist threats and maintain its sustainable development and is a measure of the state's competitiveness in the world economy [9]. Ensuring the economic security of the state is a set of measures aimed at protecting national economic interests from external and internal threats and creating conditions for the stable and effective functioning of the national economic system [10]. The main components of ensuring economic security are the protection of the economic sovereignty of the state from external economic threats, the stability of the national currency and the prevention of excessive inflation, the promotion of sustainable economic growth and increasing the competitiveness of the economy, the protection of strategic sectors of the economy, food security, the creation of favorable conditions for business development, and the fight against the shadow economy, social protection of the population [11].

Economic security is one of the basic dimensions of national security and is interconnected with all its other components [4]. There is a close relationship between a country's economic security and geopolitical conflicts. Economic weakness can provoke external aggression and conflicts. Countries with weak economies are more vulnerable to encroachment and expansion. Economic sanctions and restrictions are often used as a pressure tool in international conflicts. They can significantly harm the economic security of the country under sanctions. Military conflicts cause significant damage to economic security through the destruction of infrastructure, disruption of supply chains, outflow of investment, etc. Cyber attacks and other hybrid threats can be aimed at undermining the opponent's economic security [12]. Countries may resort to economic espionage or theft of intellectual property to gain a competitive advantage that threatens the security of others. Economic claims and disputes over resources, territories, borders are often a source of conflicts. Strengthening economic security is an important factor in preventing conflicts and strengthening the country's international position. Today, a clear understanding of the determinants of national economic security and a multi-faceted qualitative analysis of assessments of the impact of various factors on sustainable economic development and national security of the countries of the world is necessary.

Assessing the state of economic security of the countries of the world is a complex problem that has been studied by scientists from all over the world for many years. To date, a unified system of indicators that would reliably and fully identify the real level of economic stability has not yet been developed. It is also practically impossible to directly measure all the values that assess the volumes and characteristics of the determinants of economic security. Often, the number and content of factors that have a significant impact on economic stability are unknown. However, models built based on empirical data provide an opportunity to obtain new information important for decision-making in the field of economic security. The purpose of this study is to improve understanding of the risks, challenges and opportunities for economic security, which is a significant component of national security. The obtained results can provide additional information regarding the determination of priority directions for the economic national security sector and the development of effective national security strategies.

2 RELATED WORK

Economic security is a complex debatable issue. Many modern researchers update the problems of the importance of ensuring economic security in the context of geopolitical transformations and growing global threats [11]. L. Retter et al. investigated the relationship between the economy and national security in the context of globalization and economic integration [4]. I. Gryshova et al. proved that the security of the national economy characterizes the country's ability to resist the destabilizing effects of various internal and external threats and ensure its sustainable development [13]. J. Jekl et al. developed the theoretical foundations of the possible application of economic and geographic metrics for assessing national security based on well-known metrics and actual data [14]. J. Li et al. explored the advantages of economic security and environmental protection from the point of view of sustainable development and the scientific and technical ecological environment. They proposed a system of indicators for the coordinated development of eco-technological innovations and the economic environment [15]. O. Solosich et al. proposed a methodological toolkit for assessing the economic security of regions as a possible potential-forming space in terms of intellectualization [16]. G. Yuan et al. studied the regularities of economic security and economic fluctuations as an important component of ensuring economic stability and scientific development. Based on cloud computing technology and intelligent data analysis, they developed a model that can adaptively assess and warn about the state of economic security [17]. M. Mogyorós et al. created a structural equation model for measuring and monitoring economic insecurity based on macroeconomic data of individual EU countries for 2005-2020 [18]. A. Sunduk et al. investigated the peculiarities of ensuring the economic security of regions in the event of risks and threats in the information sphere. They received assessments of the level of economic security based on the system of indicators of national economic security and its regions [19]. The problem of ensuring economic security, which determines the state's ability to resist various internal and external threats, to ensure sustainable development and competitiveness in the global economic system, is becoming more and more urgent in the context of the aggravation of the global political crisis. Research on the application of statistical modeling to improve the understanding and assessment of the determinants of economic security in the context of ensuring sustainable development and strengthening national

security today has acquired a new meaning and requires a more detailed multifaceted study and transparent understanding.

3 METHODOLOGY

Today, there are various theoretical and methodological approaches to monitoring and assessing the state of economic security of the world's countries and the level of national security. Different scientists use different sets of macroeconomic indicators, aggregate indicators, and indices. Representatives of economic science use a set of indicators that reflect the most important areas of economic security: gross domestic product (GDP), the share of fixed capital investment in GDP, the share of defense expenditures in GDP, the share of expenditures on social sciences in GDP, the share of innovative products in total industrial output, etc. [20]. Researchers in the field of social sciences calculated the coefficient of economic security based on a system of the following indicators: gross product, revenues of the budget, budget expenditures, amount of actual revenues from taxes and fees to state trust funds, capital investments, foreign direct investment, volume of exports of goods, and cost of research [19]. Individual researchers identified threats to economic security at the macroeconomic level (median income, GINI coefficient, risk of poverty, social government expenditures, Internet access, number of deaths in mental disorders, Democracy Index) and microeconomic level (unemployment, sickness disability, widowhood, divorces, old age) [18]. Empirical comparisons of the economic security of the world's countries are complicated by the fact that not all countries of the world have reliable estimates of many generally accepted indicators.

The economic system is extremely complex. Thousands of economic indicators have been developed that characterize its development. The redundancy of such information creates significant difficulties in assessing the real state of national economic security. We offer an approach based on the development of statistical models based on empirical data, which can provide information about the most important indicators that determine the state of economic security of the state and significantly affect the level of national security. Based on literature review, we formed the empirical base of our research from the following reliable indicators of the state of various areas of development of national economies, which can be potential significant determinants of the impact on national economic security: economies by corruption levels; informal economy (size as a percentage of GDP) [21]; GDP per capita, unemployment rate, inflation rate [22]; poverty rate by country [23]; external debt [24]; Gini coefficient (measures economic inequality) [25]; WB – well-being (measures feeling healthy and happy), WBG – well-being gaps between the top and bottom halves of each country's populations [26]; Index of Economic Freedom [27]; Global Food Security Index [28]; foreign direct investment, exports of goods and services, imports of goods and services, military expenditure (percentage of GDP) [29]; social spending public [30]; e-security (aggregated measure of Internet affordability, Internet quality, E-infrastructure, E-security, E-government) [31].

According to the concept of sustainable development, GDP is not an adequate assessment of economic development and economic security of countries, but only an averaged expression of the level of economic security of citizens. Important in this regard are measures of well-being, equal opportunities, poverty level, economic freedom, access to benefits, etc. Most of these dimensions are taken into account when evaluating the Human Development Index (HDI) [32]. In our research, we chose the HDI as the optimal approximate measure of the level of economic security of the countries of the world.

While there is no universal aggregate measure, different countries use different theoretical approaches to national security assessment [2, 3, 6, 11, 35]. For example, the Safety Index is calculated based on the level of crime in the country [33]. The modern interpretation of national security assumes the protection of the country's citizens primarily from external threats to the geostrategic environment of the state and threats to personal security in the context of sustainable development. For this study, the Global Peace Index was chosen as an approximate measure of national security. He evaluates peaceful countries by the following domains: safety and security, ongoing conflict, and militarization [34].

To understand the state of national security, a clear idea of the aspects vital for the sustainable functioning of society is required. The assessment of the state of national security from the side of economic factors can be understood by highlighting the interaction between the determinants of the impact on economic security and the measures of national security of the countries of the world.

4 RESULTS AND DISCUSSION

The data set for empirical analysis consisted of the values of indicators selected for the study of 207 countries of the world for the year 2022, obtained from reliable statistical sources [21-32, 34].

The variables used in the empirical study were: EXP (Exports of goods and services), IMP (Imports of goods and services), GINI (Gini coefficient), ESEC (e-security), WB (well-being), WBG (well-being gaps between the top and bottom halves of populations), IEF (Index of Economic Freedom), UE (unemployment rate), FDI (foreign direct investment, net inflows), IE (informal economy), ECR (economies by corruption levels), GDP (GDP per capita), IR (inflation rate), PR (poverty rate by country), ED (external debt), ME (military expenditure), GFSI (Global Food Security Index), GPI (Global Peace Index), HDI (Human Development Index).

Empirical results obtained by Statistica software.

Factor analysis was used to aggregate the initial data and determine the significant determinants of the impact on economic security.By the principal components method, two factors are selected. Table 1 shows the calculated factor loadings, which are the correlation coefficients between the original variables and the selected factors.

Table 1: Factor loadings (Varimax normalized).

Extraction: Principal components Marked loadings are > 0.7					
Variable	F_1	F_2	Variable	F_1	F_2
GINI	-0.80	0.07	IE	-0.81	-0.42
ESEC	0.82	-0.01	ECR	0.92	0.18
WB	0.86	0.20	GDP	0.88	0.21
WBG	-0.92	-0.13	IR	-0.26	-0.20
EXP	0.15	0.92	PR	-0.78	-0.12
IMP	0.13	0.96	ED	-0.73	0.01
IEF	0.91	-0.01	ME	-0.01	0.35
UE	-0.71	-0.13	GFSI	0.87	0.28
FDI	0.04	0.90			

The higher the modulus load, the closer the factor is to the input variable. A positive sign of the factor loading indicates a direct relationship between the variable and the factor, and a negative sign indicates an inverse relationship. Factor loadings reflect the most important information for the interpretation of the obtained factors.

The variables ECR (0.92), WBG (–0.92), IEF (0.91), GDP (0.88), GFSI (0.87), and WB (0.86) are closely correlated with the first selected factor. The variables IMP (0.96), EXP (0.92), and FDI (0.90) are closely correlated with the second factor. The variables WBG, GINI, and IE have a negative impact on national economic security. IR and ME variables did not enter into any of the extracted factors.

The following factor model was constructed:

$$F_1 = 0.92\times ECR - 0.92\times WBG + 0.91\times IEF + \\ - 0.88\times GDP + 0.87\times GFSI + 0.86\times WB + \\ + 0.82\times ESEC - 0.81\times IE - 0.80\times GINI - \\ - 0.78\times PR - - 0.73\times ED - 0.71\times UE, \quad (1)$$

$$F_2 = 0.96\times IMP + 0.92\times EXP + 0.90\times FDI. \quad (2)$$

As a result of building the factor model, 2 factors were identified: the first of them is a linear combination of endogenous factors influencing the economic security of the countries of the world, and the second forms exogenous indicators of economic security.

So, in the context of the concept of sustainable development, the endogenous determinants of the impact on the economic security of most countries of the world are corruption, inequality of well-being between different strata of the population within the country, promotion of economic opportunities and prosperity, GDP, food security, well-being, which combines welfare and prosperity. The modern meaning of endogenous determinants of influence on economic security is not in a satisfactory average level of material well-being of the country's population, but in ensuring equal financial opportunities for all and guaranteeing safe and stable well-being. Import, export and foreign direct investment are exogenous determinants of the impact on the economic security of most modern countries of the world.

Canonical correlation analysis was conducted to assess complex two-way relationships between selected determinants and generally recognized reliable indices that can serve as approximate estimates of the level of economic security in the context of the concept of sustainable development (Human Development Index) and national security (GPI – Global Peace Index). This method determines the interdependencies between two sets of variables.

The set of dependent variables (left set) consists of the following variables:

- HDI – Human Development Index, which is the optimal approximate measure of the state of economic security of the countries of the world;
- GPI – Global Peace Index, which is an approximate measure of national security.

As can be seen from Figure 1, there is a direct relationship between the HDI, which we chose as an approximate measure of economic security, and the GPI, which is an approximate estimate of the level of

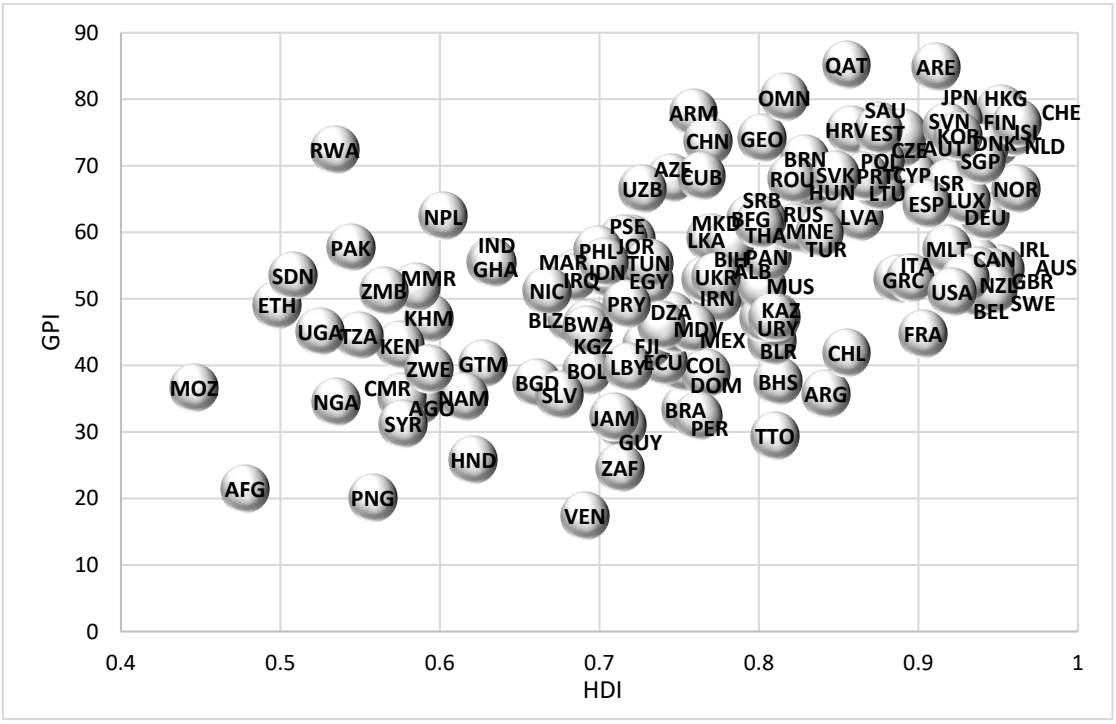

Figure 1: Plot of HDI and GPI dependence for most countries of the world.

national security, for the vast majority of analyzed countries. The set of independent variables (right set) consisted of all the indicators included in the factor model (1), (2).

Table 2 presents the overall results of the canonical analysis.

Table 2: Canonical analysis summary.

Canonical R: .96124 Chi2(30) = 126.18 p = 0.0000				
	Left Set	Right Set		
No. of variables	2	15		
Variance extracted	100.00%	54.68%		
Total redundancy	83.66%	48.95%		
Variables:	GPI	GINI	IMP	ECR
	HDI	ESEC	IEF	GDP
		WB	UE	PR
		WBG	FDI	ED
		EXP	IE	GFSI

As can be seen from Table 2, the obtained results are statistically significant ($p < 0.01$). The canonical R-value is (0.96). Hence, there is a close correlation between the variables in the left and right sets. The total share of the variance of the features of the first group, allocated with the help of the first canonical variable of the right set, is 100.00%. The total share of the variance of the features of the second group (right set) of the canonical variable of the left set is 54.68%.

The total loss for variables of the first group equals 83.66%, and for variables of the second group – 48.95%. Therefore, almost 84% of the variation in the indicators of the economic component of national security is determined by changes in the analyzed determinants of national economic security. At the same time, the indicators of the economic security of the world's countries (the left set) determine almost 49% of the variation of the studied determinants of national economic security (the right set).

The obtained results indicate the sufficient accuracy of the constructed canonical model – less than 17% of the variance of the variables of the left set depends on factors that were not included in the model due to the limitations of the canonical analysis.

As can be seen from Table 3, the first root is statistically significant ($p < 0.01$). The resulting canonical R^2 value is sufficiently large (0,92), $\chi_e^2 = 126.18$. $\chi_0^2(0.01;25) = 50.9$. $\chi_e^2 > \chi_0^2$. The first canonical root will be considered in more detail.

Table 3: Chi-square tests with successive roots removed.

Root Removed	Canonical R	Canonical R2	Chi-sqr.	df	p
0	0.96	0.93	126.18	30	0.00
1	0.78	0.60	33.42	14	0.03

The calculated canonical weights are correlations of the canonical root with the variables in the initial sets (Table 4, 5). The HDI variable is highly correlated with the canonical root. Therefore, the HDI is an adequate proxy for national economic security and the GPI is an acceptable measure of national security in the context of our study.

Table 4: Factor structure, left set.

Variable	Root 1
GPI	0.68
HDI	0.99

Table 5: Factor structure, right set.

Variable	Root 1	Variable	Root 1
GINI	-0.66	FDI	0.37
ESEC	0.85	IE	-0.86
WB	0.90	ECR	0.89
WBG	-0.92	GDP	0.83
EXP	0.30	PR	-0.60
IMP	0.29	ED	0.63
IEF	0.82	GFSI	0.95
UE	-0.26		

The following canonical model was obtained:

$$Z_y = 0.99 \times HDI + 0.68 \times GPI, \quad (3)$$

$$\begin{aligned} Z_x = {} & 0.95 \times GFSI - 0.92 \times WBG + 0.90 \times WB + \\ & + 0.89 \times ECR - 0.86 \times IE + 0.85 \times ESEC + \\ & + 0.83 \times GDP + 0.82 \times IEF - 0.66 \times GINI + \\ & + 0.63 \times ED - 0.60 \times PR + 0.30 \times EXP + \\ & + 0.29 \times IMP + 0.37 \times FDI - 0.26 \times UE. \end{aligned} \quad (4)$$

As can be seen from Figure 2, there are no sharp outliers and deviations from the regression line. For example, formations in the form of U or S. Therefore, it can be concluded that no noticeable violations of the main assumptions of canonical analysis are observed.

The built model (3), (4) gives reason to state that the most important determinants of the impact on economic security in the context of sustainable development and national security of the countries of the world are food security, inequality of well-being between different layers of the population, well-being, corruption, informal economy, e-security, GDP, Index of Economic Freedom and economic inequality.

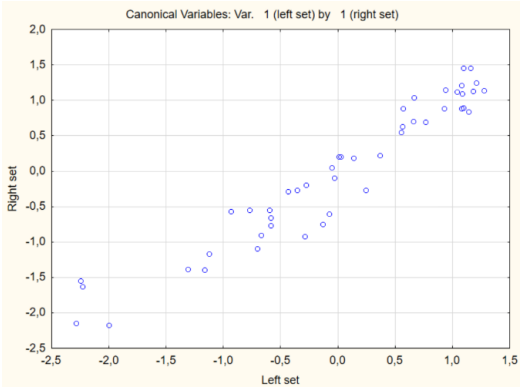

Figure 2: Graphic representation of canonical values.

5 CONCLUSIONS

We hope you find the information in this template useful in the preparation of your submission.

The concept of economic security in the modern context is extremely complex and multifaceted and includes a wide range of aspects related to ensuring the stability and sustainability of national economies in the context of sustainable development. Economic security is one of the basic dimensions of national security and is interconnected with all its other components. This paper proposes an approach based on multivariate statistical modeling to determine and evaluate the determinants of the impact on the economic security of the countries of the world in the context of sustainable development and national security. Based on reliable statistical indicators of 207 countries of the world for 2022, a factor model was built. 2 factors are identified, which are latent indicators, calculated as linear combinations of initial indicators. For most countries of the world, the endogenous determinants of the impact on economic security are corruption, inequality of well-being between different strata of the population within the country, promotion of economic opportunities and prosperity, GDP, food security, well-being, which combines welfare and prosperity, ensuring equal financial opportunities for everyone and guaranteeing safe and stable well-being. The factor of endogenous determinants of influence was formed by import, export, and foreign direct investment.

The authors developed a model of canonical correlations for evaluating complex two-way relationships between the determinants selected as a result of factor analysis and approximate estimates of the level of economic security in the context of the concept of sustainable development (HDI) and national security (GPI). The obtained results are only

approximate. However, they can be used to improve the understanding of the problems of maintaining sustainable economic growth, ensuring economic security, developing anti-crisis strategies of states and providing useful information for making managerial decisions in the field of strengthening the economic and national security of most countries of the world. The issue of our next research will be the assessment of the impact of modern international military conflicts on national economic security.

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