“Role of government policy in food security: Economic and demographic challenges”

AUTHORS	Eldar Guliyev Bayali Atashov Aygun Guliyeva
ARTICLE INFO	Eldar Guliyev, Bayali Atashov and Aygun Guliyeva (2024). Role of government policy in food security: Economic and demographic challenges. *Problems and Perspectives in Management*, *22*(2), 488-501. doi:10.21511/ppm.22(2).2024.38
DOI	http://dx.doi.org/10.21511/ppm.22(2).2024.38
RELEASED ON	Friday, 31 May 2024
RECEIVED ON	Friday, 15 March 2024
ACCEPTED ON	Thursday, 09 May 2024
LICENSE	
JOURNAL	"Problems and Perspectives in Management"
ISSN PRINT	1727-7051
ISSN ONLINE	1810-5467
PUBLISHER	LLC “Consulting Publishing Company “Business Perspectives”
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10,
Sumy, 40022, Ukraine

www.businessperspectives.org

Eldar Guliyev (Azerbaijan), **Bayali Atashov** (Azerbaijan), **Aygun Guliyeva** (Azerbaijan)

ROLE OF GOVERNMENT POLICY IN FOOD SECURITY: ECONOMIC AND DEMOGRAPHIC CHALLENGES

Abstract

The state policy on food security should take into account economic (e.g., expansion of agricultural production following domestic food demand, exports, and imports) and demographic (e.g., adequacy of food reserves and production capacities of the agrosector to the pace of population growth, considering urbanization, migration, and a culture of rational consumption) challenges. Government policy should maintain the balance between the stability of the food system, economic development, and demographic changes. Therefore, this study aims to identify implicit (hidden) structural and functional relationships between these elements. The paper employs structural modeling using STATISTICA; the dataset consists of six food security, eight economic, and seven demographic indicators (using World Bank and Food and Agriculture Organization databases for 2011–2021, targeting 39 countries with different levels of GDP per capita (depending on the availability of statistical data)). The results proved the direct impact of the economic variable on food security and the indirect effect of the demographic variable (demographic changes are the engine that triggers economic transformations that further affect food security). When demographic changes increase by one unit, economic development increases by 0.57 and stability of the food system by 0.454. When economic development increases by one unit, the stability of the food system increases by 0.473.

Received on: 15th of March, 2024
Accepted on: 9th of May, 2024
Published on: 31st of May, 2024

Eldar Guliyev, Doctor in Economics, Professor, Rector, Azerbaijan Cooperation University, Azerbaijan. (Corresponding author)

Bayali Atashov, Doctor in Economics, Professor, Vice-Rector for Science and Innovation, Azerbaijan Cooperation University, Azerbaijan.

Aygun Guliyeva, Doctor in Economics, Professor, Vice-Rector for International Relations and Training, Azerbaijan Cooperation University, Azerbaijan.

Keywords government regulation, agriculture, economic growth, demography, management, security, structural modeling

JEL Classification Q18, O13, J11

INTRODUCTION

Ensuring the country's food security is one of the goals of sustainable development of society, which is enshrined in the United Nations General Assembly Resolution "Transforming our world: The 2030 Agenda for Sustainable Development" (United Nations, 2015). The importance of ensuring food security is recognized globally, as evidenced by the adoption and signing of various international legal documents to define the main goals and objectives for ensuring food security (FAO, 1996). This document establishes the concept of "food security" at the global level and defines strategic goals and objectives for ensuring food security worldwide (FAO, 1996). The United Nations develops a strategic framework for its activities, defining priority work areas. The latest Strategic Framework Program of the Food and Agriculture Organization (FAO) was created in 2021 and formulates the organization's vision for a sustainable and food-secure world in the field of innovation, healthy nutrition, mitigating the effects of climate change, and supporting the transformation of rural areas by 2030 (FAO, 2021). The priority areas identified in the Strategic Framework Program of FAO aimed at solving food security problems should become a beacon for states to build a balanced policy to improve well-being in the world. According to the FAO's recommendations, governments are developing their internal strategies and programs to ensure food security. Within the framework of these strategies and programs, countries are

Conflict of interest statement:
Author(s) reported no conflict of interest

http://dx.doi.org/10.21511/ppm.22(2).2024.38

developing measures, mechanisms, and tools to support and develop the agricultural sector, social support of the population, access to quality products, etc. Depending on the effectiveness of the developed strategies and programs, they may be adjusted periodically, considering new FAO recommendations.

For example, Azerbaijan's state policy aims to support the agricultural sector comprehensively. Subsidies cover more than 50% of the cost of mineral fertilizers needed to process one hectare of land. The state also assumes part of the costs of purchasing agricultural machinery and allocates funds for subsidies to fuel and motor oil necessary for land cultivation. In addition, the government of Azerbaijan pays great attention to the protection, restoration, and effective use of land, which made it possible to increase the area of arable land by 0.3% during 2010–2016. The increased expenditure on agriculture contributed to the rise in the added value created in agriculture and the reduction of malnutrition. In Belgium and Sweden, government policy in this area mainly focuses on preserving the biodiversity of agricultural lands (increasing the area of land allocated for organic farming production, reducing greenhouse gas emissions per production unit, and decreasing the use of antibiotics in animal husbandry). In addition, Sweden's public policy in the field of food security is focused on conserving seeds and genetic resources, which makes it possible to bring old cultivated plant varieties back into circulation.

Humanity's concern about issues related to food security is fully justified given climate change, armed conflicts, political upheavals, which entail a decrease in agricultural production, and the complication of logistics, which in turn leads to an increase in prices due to food shortages (Hamulczuk et al., 2023).

1. LITERATURE REVIEW

The limitation of food resources has been one of the biggest global and local problems for over a decade. Therefore, research on overcoming hunger and achieving food security is essential and relevant to ensuring society's sustainable development. One of the critical players is government policy, which can set the course of the country's development with its decisions (Aiyedogbon et al., 2022). Hadouga (2023) and Bouchafaa et al. (2023) highlight the importance of state policy in regulating socioeconomic and demographic development. Litovtseva et al. (2022), Pakhnenko and Kuan (2023), and Gentsoudi (2023) researched the role of the public sector as the leading reformer. Zolkover et al. (2022) and Lyeonov et al. (2022) emphasize the role of state institutions and public policy in ensuring effective changes.

Government policies play a crucial role in shaping the economic conditions that influence food security. Agricultural subsidies, trade policies, and investment in rural infrastructure are among the key policy instruments used to support agricultural production and enhance food access. However, the effectiveness of these policies is often undermined by economic factors, such as market volatility, income inequality, and resource constraints. For example, Tu et al. (2023) investigated that trade liberalization policies may increase food availability through imports, but they can also expose domestic producers to greater competition and price fluctuations, affecting their livelihoods and food security. Dubanych et al. (2023) focus on the role of retail trade in ensuring food security. They established that the presence of unresolved market distortions can lead to a decrease in food security. Therefore, policymakers face the challenge of balancing the need for market-oriented reforms with measures to protect vulnerable populations and promote sustainable agricultural development. Tiutiunyk et al. (2022) discovered that food security is significant for ensuring the macroeconomic stability of countries. Economic, environmental, energy, and food security are interrelated and interdependent categories, as undermining one of them entails a chain reaction of negative consequences for others (Wang et al., 2023); therefore, governments must maintain an adequate level of each element of national security to ensure the well-being of society (Romenska et al., 2024).

In the last decade, the category of "sustainable development" has gained particular importance, as it combines many different goals that aim to establish a balance between the needs of today's society and the protection of the interests of future generations. Therefore, the vectors of the state policy on ensuring food security must be coordinated with the directions of the state policy on ensuring sustainable development as a whole (Brychko et al., 2023; El Fallahi et al., 2023). Scientists are actively researching food security in different countries to assess their achievement of sustainable development goals. Using the example of India, Singh and Pandey (2023) concentrated on the conceptual combination of sustainable development goals and the level of food security.

Food security must be considered when developing and implementing state policy following demographic trends, including population growth, urbanization, and migration (Hoxhaj et al., 2022; Ramli et al., 2022). Kovljenić and Škorić (2023) consider various factors influencing food security, particularly demographic factors. They have studied the impact of the population on food security and established that population growth leads to food shortages. Therefore, the government needs to stimulate an increase in output or decrease fertility (Aiyedogbon et al., 2022; Götmark & Andersson, 2023). Ilychok et al. (2023) noted that rapid population growth strains food production and distribution systems, exacerbating pressure on natural resources and agricultural land. In addition to high birth rates, a security threat, including food security, is posed by migration, as it causes an additional burden on the food supply in the host country (Kuzior et al., 2020). However, this threat can be reduced by creating additional capacities in the production of products (Mullens & Shen, 2023; Kuzior et al., 2021). Kuzior et al. (2022) and Court (2022) discussed that urbanization leads to changes in dietary preferences and consumption patterns, affecting demand for food and agricultural products. Moreover, migration patterns, both internal and external, influence labor markets, remittances, and food access in sending and receiving communities. Government policies aimed at addressing demographic challenges often focus on improving family planning services, promoting rural development, and strengthening social safety nets (Shynkaruk et al., 2023; Djamal et al., 2023). However, the effectiveness of these policies depends on their alignment with broader development goals, including poverty reduction, education, and health care (Bhandari, 2023).

The relationships between the stability of the food system, economic development, and demographic changes are complex and multifaceted. The scientific literature demonstrates an interesting toolkit for analyzing the structural internal connections between these elements. For example, economic growth can lead to improved access to food and nutrition, but it can also exacerbate income inequality and environmental degradation (Bilan et al., 2019; Orlov et al., 2021; Anand & Sharma, 2023). Similarly, demographic changes, such as aging populations or youth bulges, can influence labor markets, social welfare systems, and intergenerational transfers, affecting food security dynamics in both rural and urban areas (Muharremi et al., 2022). Kuzior and Lobanova (2020) investigated the specific features of the relationship between economic, environmental, and demographic factors using the example of industrial regions. In food security research, an essential determinant is agriculture, which is considered the world's primary food source. The critical role of investing in agriculture because its financing will expand the capabilities of the agricultural sector, increasing its production to provide for a larger population (Bhowmik, 2022; Thiam & Toure, 2020; Juhászová et al., 2023).

A clear definition is an essential component of effective government food security policy. Nilsson et al. (2020), using regression analysis based on data from Chad, found that population and international aid affect agriculture in the long run, in addition to farm support programs, market prices, access to new markets, and refugee accommodation. Mason-D'Croz et al. (2019), using economic-mathematical modeling, analyzed the role of fruit and vegetable production in ensuring recommended consumption levels. They found that most of the population is underserved by fruits and vegetables, and even under optimistic socio-economic scenarios, this supply will not reach recommended levels in many countries. To solve this problem, scientists recommend implementing a systemic state policy to eliminate restrictions on producing and consuming fruits and vegetables. Shi et al. (2023) investigated the structural formation of the agricultural sector to optimize the supply of agricultural products in China. Toledo et al. (2023) analyzed the relationship between water, energy, and food security to build an effective agrarian policy. Blikhar et al. (2023) studied the legal aspects of ensuring food security. Oussou et al. (2023) and Singh (2022) focused on ways to improve the processing of certain products to affect food security and reduce environmental pollution. Richardson (2023) investigated what role beekeeping can play in strengthening food security and public health. Questions about

http://dx.doi.org/10.21511/ppm.22(2).2024.38

how vulnerable agriculture is to climate change were investigated by Sporchia et al. (2021) and Serkendiz et al. (2023), and how to insure against these risks – by Rakotoarisoa and Mapp (2023). Yerankin et al. (2023) formed a set of national indicators of food security. Gu et al. (2023) suggested evaluating the effectiveness of food security based on the concept of One Health, analyzing the Global Single Health Index and socio-economic indicators.

When forming the state policy of ensuring food security, it is essential to choose the appropriate tools for its implementation. Sampling OECD countries, Niyaz and Allahverdi (2023) concluded that soft but effective government intervention is needed from the perspective of agrarian risk and food security, one option of which is subsidies. In general, subsidization is one of the effective mechanisms of state support. For example, in Azerbaijan, subsidies support local farmers in developing grain production, purchasing seeds and seedlings, and covering part of the costs for mineral fertilizers. They help farmers improve the productivity of agriculture and increase food production. In addition, one of the priority areas of Azerbaijan's government policy is ensuring effective land use, including climate adaptation (development of crop and animal husbandry by climate change or resistance to it) (FAO, 2017).

Thus, the literature analysis showed that the study of food security is necessary both in each individual country and in the world in general. Therefore, this study aims to identify implicit (hidden) structural and functional relationships between the stability of the food system, economic development, and demographic changes.

2. METHODOLOGY

This study used data from the World Bank (World Bank, n.d.) and FAO (FAO, n.d.) databases. These data characterize the main economic (econ1-econ8), demographic (dem1-dem7), and food security indicators (prod1-prod6). For the study, indicators were chosen according to the FAO grouping, referring to those that characterize the stability of food security to assess the impact of economic and demographic determinants on its sustainability. Table 1 presents the indicators selected for the study. The study targeted 39 European countries, which can be conditionally divided into three groups depending on the level

Table 1. Definitions of the selected variables

Designation of the variable	Variable	Units	Source
prod1	Per capita food supply variability	kcal/cap/day	FAO (n.d.)
prod2	Value of food imports in total merchandise exports	percent (3-year average)	FAO (n.d.)
prod3	Cereal import dependency ratio	percent (3-year average)	FAO (n.d.)
prod4	Percent of arable land equipped for irrigation	percent (3-year average)	FAO (n.d.)
prod5	Political stability and absence of violence/terrorism	index	FAO (n.d.)
prod6	Per capita food production variability	(constant 2014–2016 thousand $ per capita)	FAO (n.d.)
econ1	GDP per capita	(current US$)	World Bank (n.d.)
econ2	Gross fixed capital formation	% of GDP	World Bank (n.d.)
econ3	Agriculture, forestry, and fishing, value added	% of GDP	World Bank (n.d.)
econ4	Imports of goods and services	% of GDP	World Bank (n.d.)
econ5	Unemployment, total	% of the total labor force (modeled ILO estimate)	World Bank (n.d.)
econ6	Foreign direct investment, net inflows	% of GDP	World Bank (n.d.)
econ7	Inflation, consumer prices	annual %	World Bank (n.d.)
econ8	Personal remittances, received	% of GDP	World Bank (n.d.)
dem1	Total population	people	World Bank (n.d.)
dem2	Birth rate	crude (per 1,000 people)	World Bank (n.d.)
dem3	Death rate	crude (per 1,000 people)	World Bank (n.d.)
dem4	Rural population	people	World Bank (n.d.)
dem5	Urban population	people	World Bank (n.d.)
dem6	Net migration	people	World Bank (n.d.)
dem7	Population growth	annual %	World Bank (n.d.)

of GDP per capita (Appendix A). The higher the value of GDP per capita, the higher the standard of living in the country. The data are taken for the period from 2011 to 2021.

The relationships between economic, demographic, and indicators of stability of food security are studied using structural modeling appropriate for complex relationships between the studied phenomena. The main advantage of this method is that it investigates implicit relationships between the elements of a multi-level system by constructing a system of linear regression equations. In addition, factor and correlation analyses were used to select the most relevant indicators and analyze the closeness of the relationship between them. All calculations were performed in STATISTICA.

The modeling process can be conditionally divided into stages:

1. Forming a database of input data describing the studied phenomena and using the method of principal components, selecting the most relevant indicators for each group of implicit variables, and checking the absence of high correlation between the chosen variables within each group.
2. Designating latent (implicit) variables for each group of indicators that will characterize it and defining functional relationships between the explicit and implicit variables.
3. Visualizing relationships between explicit and implicit variables using a path diagram (Figure 1).
4. Employing STATISTICA to form and interpret the system of regression equations (1).

$$\begin{cases} LAT1 = a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n + \varepsilon_1 \\ LAT2 = b_{21}LAT1 + a_{21}x_1 + a_{22}x_2 \\ + \ldots + a_{2n}x_n + \varepsilon_2 \\ LAT3 = b_{31}LAT1 + b_{32}LAT2 + a_{21}x_1 \\ + a_{22}x_2 + \ldots + a_{2n}x_n + \varepsilon_2 \end{cases}, \quad (1)$$

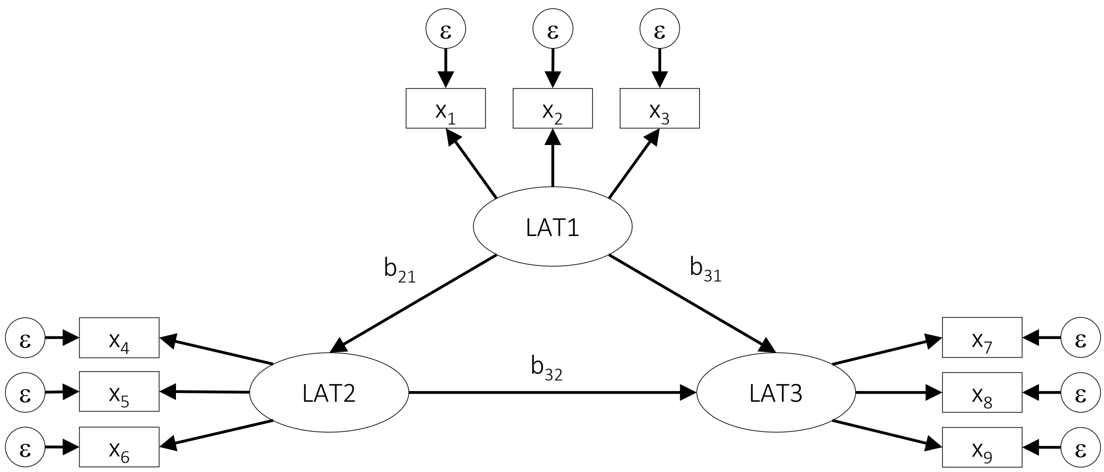
where $LAT1$, $LAT2$, $LAT3$ – implicit variables; x_n – explicit variables; a_{mn} and b_{mn} – regression parameters; ε – random errors.

5. Checking the adequacy and stability of the constructed model.

3. RESULTS AND DISCUSSION

Table 2 shows the results of descriptive statistics for the input data. These statistics provide a quantitative data description to understand data characteristics and distribution.

The results of descriptive statistics show that most of the selected variables have a wide range between their maximum and minimum values, which can be explained by the wide selection of the studied



*Note: LAT*1, *LAT*2, *LAT*3 – implicit variables; x_n – explicit variables; a_{mn} and b_{mn} – regression parameters; ε – random errors.

Figure 1. Functional relationships between explicit and implicit variables

http://dx.doi.org/10.21511/ppm.22(2).2024.38

Table 2. Descriptive statistics for the input array

Variable	Obs	Mean	Median	Min	Max	Std.Dev.
prod1	429	42	34	7	213	30
prod2	429	14	8	3	132	19
prod3	429	–17	9	–487	94	89
prod4	407	4	2	0	18	5
prod5	429	0	1	–2	1	1
prod6	429	32	25	3	126	22
econ1	429	29555	19486	2125	133712	27149
econ2	429	22	21	11	42	4
econ3	428	4	3	0	20	4
econ4	429	56	52	24	180	24
econ5	429	10	8	2	32	6
econ6	429	4	3	–117	107	12
econ7	420	3	2	–2	49	4
econ8	429	4	2	0	23	5
dem1	429	17476739	7199077	518347	84147318	23230834
dem2	429	11	10	7	19	2
dem3	429	11	10	5	22	3
dem4	429	4592750	1843070	53305	21226473	5749386
dem5	429	12883985	5098727	399777	64513567	17896405
dem6	429	28329	2995	–261813	703144	96863
dem7	429	0	0	–4	2	1

Note: obs – number of observations, mean – average value, median – median, min – minimum value, max – maximum value, Std. Dev. – standard deviation (dispersion).

objects, which have different socio-economic development. Food security stability indicators have relatively small mean and median values. The same can be said about economic indicators, except GDP per capita, which has an average value of 29.555 and a median value of 19.486, as well as a minimum value of 2.125 and a maximum value of 133.712. Such a gap is due to the different countries' development. Demographic indicators have a more extensive spread of values. The average population size for the sample is 17,476,739, and the median is 7,199,077. The mean and median of birth and death rates have the same value and are 11 and 10, respectively. The average value of indicators for rural and urban populations is 4,592,750 and 12,883,985, respectively. Based on this, urbanization is widespread in the studied countries.

Table 3. Principal components analysis for three groups of indicators

Indicators of food security stability						
Variable	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**
prod1	0.176645	–0.577982	–0.422919	0.632237	–0.225845	0.071719
prod2	–0.351188	–0.468337	–0.615022	–0.406288	0.280328	0.188207
prod3	–0.859810	0.058205	–0.168759	0.253208	0.174802	–0.366319
prod4	–0.477040	–0.369890	0.667608	0.246450	0.254210	0.254073
prod5	0.115810	0.774869	–0.311396	0.350901	0.349942	0.208822
prod6	0.742621	–0.375052	0.091778	0.054233	0.497401	–0.221537

Economic indicators								
Variable	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**	**Factor 7**	**Factor 8**
econ1	0.81712	0.14924	0.05329	–0.18214	0.055943	0.05084	0.51795	0.00713
econ2	0.09864	0.68877	–0.30740	0.29534	–0.47699	0.32319	–0.02251	–0.04076
econ3	–0.89510	0.20131	0.00709	–0.04597	–0.13739	–0.09056	0.18726	0.30653
econ4	0.26838	0.53793	0.49977	–0.55351	0.08456	0.14399	–0.22317	0.06914
econ5	–0.54113	–0.44847	0.42938	–0.02354	–0.14098	0.53186	0.11846	–0.06595
econ6	–0.01802	0.33881	0.57527	0.66838	0.31755	–0.06892	0.04024	–0.00365
econ7	–0.44091	0.25057	–0.44703	–0.07369	0.67217	0.28933	0.03526	–0.02799
econ8	–0.78669	0.35612	0.12125	–0.24649	–0.10355	–0.28094	0.14379	–0.26175

Table 3 (cont.). Principal components analysis for three groups of indicators

Demographic indicators						
Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
dem1	0.954549	–0.249551	0.106188	–0.098206	–0.005462	–0.074904
dem2	0.161912	0.644865	0.677599	0.310202	–0.050019	–0.008072
dem3	–0.386826	–0.811016	0.109130	0.226557	–0.359019	–0.022065
dem4	0.888606	–0.304295	0.199502	–0.162918	–0.050124	0.221198
dem5	0.953602	–0.226177	0.073745	–0.075141	0.009013	–0.168292
dem6	0.713081	–0.000903	–0.407938	0.564261	0.070895	0.041051
dem7	0.396588	0.773598	–0.316619	–0.138141	–0.353449	–0.002714

The next step is to analyze whether the variables selected by the method of principal components (Table 3) have a strong relationship within the group. Table 4 shows the correlation matrix with paired correlation coefficients separately for each group of indicators. Having studied the results of the correlation analysis, in the group of indicators of food security stability, cereal import dependency ratio (prod3), political stability and absence of violence/terrorism (prod5), and per capita food production (prod6) were determined as the most relevant.

In the group of economic indicators, GDP per capita (econ1), agriculture, forestry, and fishing, value added (econ3), and personal remittances received (econ8) are the most relevant. However, econ3 and econ8 have a strong correlation between them, which is 0.77, so it was decided to replace econ8 with econ5 (unemployment, total), which is the next factor load indicator, which does not have a strong correlation with econ1 and econ3. In the demographics group, almost all indicators are relevant, so the three with the highest factor loading and uncorrelated indicators were selected: total

Table 4. Correlation analysis for the array of input data by groups of indicators

Indicators of food security stability						
Variable	prod1	prod2	prod3	prod4	prod5	prod6
prod1	1.000000	0.162076	–0.019814	–0.036197	–0.137911	0.215202
prod2	0.162076	1.000000	0.255668	–0.050879	–0.217223	–0.065888
prod3	–0.019814	0.255668	1.000000	0.289737	0.071604	–0.494000
prod4	–0.036197	–0.050879	0.289737	1.000000	–0.321258	–0.070737
prod5	–0.137911	–0.217223	0.071604	–0.321258	1.000000	–0.086363
prod6	0.215202	–0.065888	–0.494000	–0.070737	–0.086363	1.000000

Economic indicators								
Variable	econ1	econ2	econ3	econ4	econ5	econ6	econ7	econ8
econ1	1.000000	0.091019	–0.605719	0.323980	–0.401890	–0.020162	–0.262903	–0.485777
econ2	0.091019	1.000000	0.054167	0.088285	–0.262043	0.077644	0.017985	0.023640
econ3	–0.605719	0.054167	1.000000	–0.148204	0.371385	0.026720	0.324787	0.774408
econ4	0.323980	0.088285	–0.148204	1.000000	–0.125182	0.102657	–0.077471	0.078074
econ5	–0.401890	–0.262043	0.371385	–0.125182	1.000000	0.012667	0.001148	0.223329
econ6	–0.020162	0.077644	0.026720	0.102657	0.012667	1.000000	–0.018552	0.033050
econ7	–0.262903	0.017985	0.324787	–0.077471	0.001148	–0.018552	1.000000	0.261564
econ8	–0.485777	0.023640	0.774408	0.078074	0.223329	0.033050	0.261564	1.000000

Demographic indicators							
Variable	dem1	dem2	dem3	dem4	dem5	dem6	dem7
dem1	1.000000	0.035993	–0.173902	0.945044	0.994469	0.578702	0.167590
dem2	0.035993	1.000000	–0.423267	0.033013	0.036114	0.009613	0.323387
dem3	–0.173902	–0.423267	1.000000	–0.098972	–0.193943	–0.218146	–0.719706
dem4	0.945044	0.033013	–0.098972	1.000000	0.905477	0.466137	0.093464
dem5	0.994469	0.036114	–0.193943	0.905477	1.000000	0.601447	0.187519
dem6	0.578702	0.009613	–0.218146	0.466137	0.601447	1.000000	0.308145
dem7	0.167590	0.323387	–0.719706	0.093464	0.187519	0.308145	1.000000

http://dx.doi.org/10.21511/ppm.22(2).2024.38

population (dem1), death rate (dem3), and net migration (dem6).

Thus, the preliminary analysis identified three variables in each group, which, to a greater extent, characterize the stability of food security and economic and demographic components.

The next step is the introduction of latent variables for each group of indicators, which relevant manifest variables will represent:

- PROD: Cereal import dependency ratio; political stability and absence of violence/terrorism; per capita food production variability;
- ECON: GDP per capita; agriculture, forestry, and fishing, value added; unemployment, total;
- DEM: Total population; death rate; net migration.

Figure 2 presents a graphical interpretation of functional relationships between explicit and latent (implicit) variables.

Next, Table 5 presents the results of structural modeling.

Table 5. Structural modeling

Direction	Parameter	t-criterion	p-level
DEM => ECON	0.570	4.061	0.00
DEM => PROD	0.454	2.022	0.043
ECON => PROD	0.473	1.961	0.05

Note: DEM = demographic indicators; ECON = economic indicators; PROD = stability of food security indicators.

All obtained regression parameters can be called statistically significant since their *p*-level is equal to or less than 0.05; therefore, based on Table 5, a system of regression equations can be formed (2):

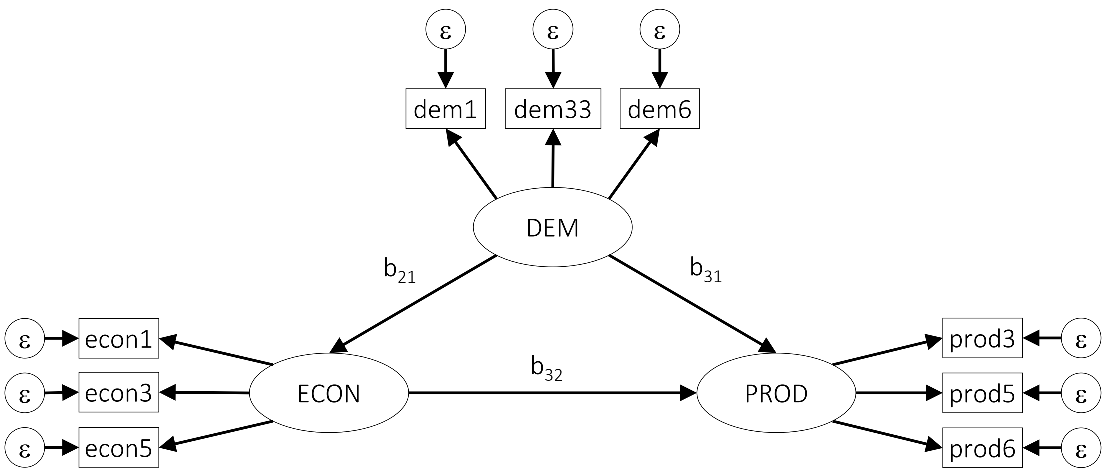
$$\begin{cases} ECON = 0.57 \cdot DEM + 0.553 \\ PROD = 0.454 \cdot DEM \\ +0.473 \cdot ECON + 0.500 \end{cases} . \quad (2)$$

Based on the system of equations (2), when the level of demographic indicators increases by one unit, the level of economic indicators will increase by 0.57. At the same time, an increase in the level of demographic indicators by one unit led to a rise in the level of stability of the food system by 0.454, and an increase in economic indicators by one unit led to the increase in the stability of food security will increase by 0.473. There is a direct relationship between all implicit variables.

The next research stage is checking the adequacy of the obtained model. Table 6 presents basic summary statistics.

Table 6. Basic summary statistics

Statistics	Value
Discrepancy Function	915563428.15
Maximum Residual Cosine	0.55
Maximum Absolute Gradient	44641045.30
ICSF Criterion	–915563507.75
ICS Criterion	332332344.42
ML Chi-Square	390945583820.07
Degrees of Freedom	24.00
p-value	0.00
RMS Standardized Residual	0.521



Note: DEM = demographic indicators; ECON = economic indicators; PROD = stability of food security indicators.

Figure 2. Functional relationships between explicit and implicit variables

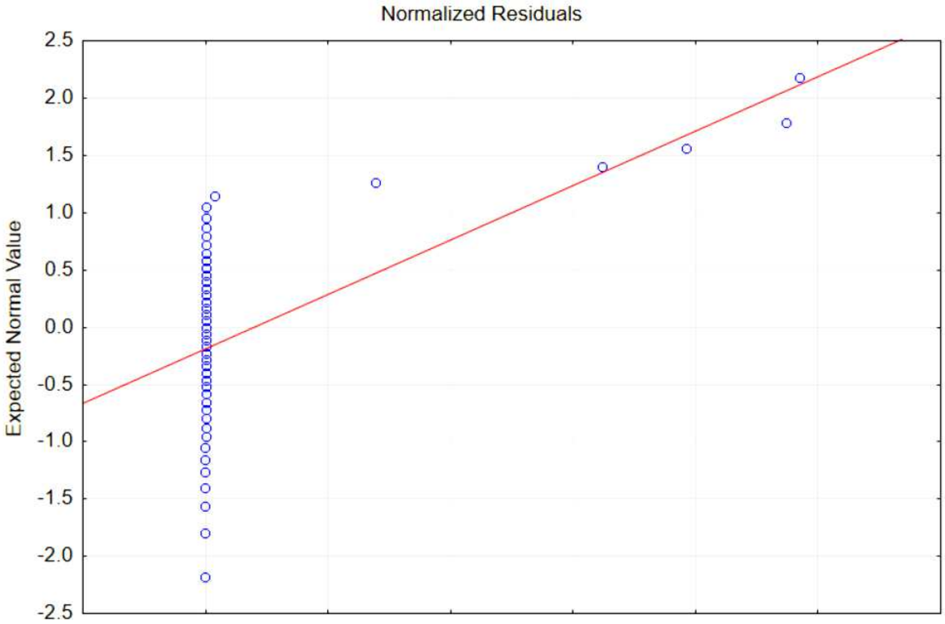


Figure 3. Normal probability plot of residual distribution

The model is adequate, as evidenced by the proximity to 0 of the Maximum Residual Cosine and RMS Standardized Residual values. A *p*-value less than 0.05 indicates that it is possible to reject the null hypothesis that there is no structural connection between the stability of food security and economic and demographic indicators. In addition, the distribution of residuals corresponds to the normal distribution law (Figure 3).

Thus, the analysis confirmed the relationships between the stability of food security and economic and demographic indicators. Moreover, the demographic component plays the leading role, and the stability of food security and the country's economic well-being depends on the change.

Aiyedogbon et al. (2022) investigated the impact of population growth on food security in Nigeria, holding significant relevance for informing government policies that address food security challenges. Overall, the study's comprehensive analysis of the relationship between population growth and food security, coupled with its consideration of multiple indicators, provides valuable insights for shaping government policies to address food security challenges in Nigeria. By incorporating these findings into policy formulation processes, policymakers can develop evidence-based strategies that effectively enhance food security and promote sustainable development.

The results are somewhat contradictory, as they do not coincide with Götmark and Andersson (2023), who established that population growth leads to a decrease in food security; that is, there is an inverse relationship between these indicators. In this study, structural modeling sheds light on the direct relationship between demographic factors and food system stability, offering valuable insights for policymakers and researchers alike. By considering the implications of demographic changes on food security, policymakers can develop informed strategies to strengthen the resilience of food systems and ensure access to nutritious food for all populations.

Dubanych et al. (2023) investigated the country's food security from the perspective of the role of food retail chains in the former "Eastern Bloc," taking into account the abnormal values of the inflation rate for food products and its impact on consumer demand. In current conclusions, further research into the relationship between food security, economic factors, and demographic indicators at the country or regional level holds promise for informing more targeted and effective policies to improve food security outcomes. By adopting a multidisciplinary approach and considering a broad range of indicators, researchers can generate valuable insights that contribute to the development of strategies for achieving food security and sustainable development goals.

http://dx.doi.org/10.21511/ppm.22(2).2024.38

CONCLUSION

The purpose of this study was to analyze the role of government policy in ensuring food security, considering economic and demographic challenges. It sought to understand in which direction it is necessary to develop government policy to effectively provide food security. Using structural modeling, it was found that demographic indicators affect the stability of the food system and economic indicators. When the level of demographic indicators increases by one unit, the level of economic indicators will increase by 0.57. An increase in demographic indicators by one unit led to a rise in the level of stability of the food system by 0.454. Finally, an increase in economic indicators by one unit led to an increase in the stability of food security by 0.473.

Government policy regarding food security should be adjusted following changes in demographic indicators so that future population growth does not lead to unexpected consequences. This study recommends the following options for government regulation of food security: stimulating the expansion of agricultural production; stimulating research in the field of breeding and increasing productivity; decreasing the rate of urbanization; forming a culture of rational consumption at the state level; limiting demographic growth (policy of small families, consolidation of permits for abortion at the legislative level); introducing stricter migration policy rules; implementing policy on prevention of armed conflicts, etc.

Food security research always stays relevant. As long as there is hunger, food security problems will remain applicable. Therefore, it is crucial to search for new ways to improve food security.

AUTHOR CONTRIBUTIONS

Conceptualization: Eldar Guliyev, Bayali Atashov, Aygun Guliyeva.
Data curation: Aygun Guliyeva.
Formal analysis: Eldar Guliyev, Bayali Atashov.
Funding acquisition: Eldar Guliyev, Bayali Atashov.
Investigation: Eldar Guliyev.
Methodology: Eldar Guliyev, Bayali Atashov, Aygun Guliyeva.
Project administration: Aygun Guliyeva.
Resources: Bayali Atashov.
Software: Aygun Guliyeva.
Supervision: Bayali Atashov.
Validation: Bayali Atashov, Aygun Guliyeva.
Visualization: Bayali Atashov, Aygun Guliyeva.
Writing – original draft: Bayali Atashov, Aygun Guliyeva.
Writing – review & editing: Eldar Guliyev.

REFERENCES

1. Aiyedogbon, J. O., Anyanwu, Sarah O., Isa, G. H., Petrushenko, Y., & Zhuravka, O. (2022). Population growth and food security: Evidence from Nigeria. *Problems and Perspectives in Management, 20*(2), 402-410. https://doi.org/10.21511/ppm.20(2).2022.33
2. Anand, A., & Sharma, M. (2023). Social norms moderating the attitude-intention relationship in adopting sustainable products. *Innovative Marketing, 19*(4), 284-296. https://doi.org/10.21511/im.19(4).2023.23
3. Bhandari, M. P. (2023). The fundamental principles of social sciences. *Business Ethics and Leadership, 7*(2), 73-86. https://doi.org/10.21272/bel.7(2).73-86.2023
4. Bhowmik, D. (2022). Role of foreign direct investment in Indian agriculture. *Financial Markets, Institutions and Risks, 6*(4), 15-31. https://doi.org/10.21272/fmir.6(4).15-31.2022
5. Bilan, Y., Brychko, M., Buriak, A., & Vasilyeva, T. (2019). Financial, business and trust cycles: The issues of synchronization. *Zbornik Radova Ekonomskog Fakultet Au Rijeci*, *37*(1), 113-138. https://doi.org/10.18045/zbefri.2019.1.113

6. Blikhar, V., Syrovackyi, V., Hodiak, A., Liuklian, M., & Starchak, B. (2023). Legal regulation of the problems of ensuring food security in Ukraine and European Union's countries in the conditions of modern challenges and dangers. *Financial and Credit Activity Problems of Theory and Practice, 4*(51), 408-416. https://doi.org/10.55643/fcaptp.4.51.2023.4137

7. Bouchafaa, B., Kherchi-Medjden, H., & Rouaski, K. (2023). Is wheat self-sufficiency in Algeria, a myth? *SocioEconomic Challenges, 7*(1), 52-58. https://doi.org/10.21272/sec.7(1).52-58.2023

8. Brychko, M., Bilan, Y., Lyeonov, S., & Streimikiene, D. (2023). Do changes in the business environment and sustainable development really matter for enhancing enterprise development? *Sustainable Development, 31*(2), 587-599. https://doi.org/10.1002/sd.2410

9. Court, T. O. (2022). Demographic characteristics and job satisfaction: The mediation role of organisational justice perceptions in public and private sector health organisations in Nigeria. *Health Economics and Management Review, 3*(4), 1-14. https://doi.org/10.21272/hem.2022.4-01

10. Djamal, D., Fariou, C., & Brahim, L. (2023). Effect of human capital on economic growth in South Africa: An ARDL approach. *Financial Markets, Institutions and Risks, 7*(4), 1-13. https://doi.org/10.61093/fmir.7(4).1-13.2023

11. Dubanych, O., Vavřina, J., & Polák, J. (2023). Development of financial performance of food retailers as an attribute behind the increase of food insecurity in selected Central and Eastern European Countries. *Investment Management and Financial Innovations, 20*(4), 416-433. https://doi.org/10.21511/imfi.20(4).2023.33

12. El Fallahi, F., Ibenrissoul, A., & El Amri, A. (2023). Defining and measuring overall performance in emerging countries: A comprehensive financial perspective review. *Financial Markets, Institutions and Risks, 7*(3), 81-93. https://doi.org/10.61093/fmir.7(3).81-93.2023

13. FAO. (1996). *Rome Declaration on World Food Security and World Food Summit Plan of Action*. Retrieved from https://www.fao.org/3/w3613e/w3613e00.htm

14. FAO. (2017). *44th Session Committee on World Food Security (CFS). CFS 2017/44/Inf. 15*. Retrieved from https://www.fao.org/about/meetings/cfs/cfs44/list-of-documents/en/

15. FAO. (2021). *Strategic Framework 2022–31*. Retrieved from https://www.fao.org/3/cb7099en/cb7099en.pdf

16. FAO. (n.d.). *FAOSTAT Suite of Food Security Indicators*. Retrieved from https://www.fao.org/faostat/en/#data/FS

17. Gentsoudi, V. (2023). The impact of effective leadership on public sector's financial instruments: Empirical evidence from Greece. *Business Ethics and Leadership, 7*(2), 47-54. https://doi.org/10.21272/bel.7(2).47-54.2023

18. Götmark, F., & Andersson, M. (2023). Achieving sustainable population: Fertility decline in many developing countries follows modern contraception, not economic growth. *Sustainable Development*, *31*(3), 1606-1617. https://doi.org/10.1002/sd.2470

19. Gu, S.-Y., Chen, F.-M., Zhang, C.-S., Zhou, Y.-B., Li, T.-Y., Qiang, N., Zhang, X.-X., Liu, J.-S., Wang, S.-X., Yang, X.-Ch., Guo, X.-K., Hu, Q.-Q., Deng, X.-B., & Han, L.-F. (2023). Assessing food security performance from the One Health concept: An evaluation tool based on the Global One Health Index. *Infectious Diseases of Poverty, 12*(1), Article 88. https://doi.org/10.1186/s40249-023-01135-7

20. Hadouga, H. (2023). Leadership in agriculture: Artificial intelligence for modelling and forecasting growth in the industry. *Business Ethics and Leadership, 7*(3), 13-19. https://doi.org/10.61093/bel.7(3).13-19.2023

21. Hamulczuk, M., Pawlak, K., Stefańczyk, J., & Gołębiewski, J. (2023). Agri-food supply and retail food prices during the Russia–Ukraine conflict's early stage: Implications for food security. *Agriculture, 13*(11), Article 2154. https://doi.org/10.3390/agriculture13112154

22. Hoxhaj, M., Muharremi, O., & Nushi, E. (2022). Analyses of demographic changes, labor market trends, and challenges in Albania. *SocioEconomic Challenges, 6*(2), 29-41. https://doi.org/10.21272/sec.6(2).29-41.2022

23. Ilychok, B., Karkovska, V., Dziurakh, Y., & Marmulyak A. (2023). Changing trends in Ukraine's demographic security as a key indicator of socioeconomic stability. *Financial and Credit Activity Problems of Theory and Practice, 2*(49), 350-360. https://doi.org/10.55643/fcaptp.2.49.2023.4020

24. Juhászová, Z., Marci, A., Zhuravka, O., Sidelnyk, N., Boyko, A., & Vasylieva, T. (2023). Modeling the structural relationships between the dynamics of agricultural insurance, the agrarian sector and the level of food security in Ukraine. *Financial and Credit Activity Problems of Theory and Practice, 4*(51), 230-244. https://doi.org/10.55643/fcaptp.4.51.2023.4113

25. Kovljenić, M., & Škorić, J. (2023). Effects of poverty on the level of food security in countries of the former Yugoslavia. *Drustvena Istrazivanja, 32*(1), 73-92. https://doi.org/10.5559/di.32.1.04

26. Kuzior, A., & Lobanova, A. (2020). Tools of information and communication technologies in ecological marketing under conditions of sustainable development in industrial regions (through examples of Poland and Ukraine). *Journal of Risk and Financial Management, 13*(10), Article 238. https://doi.org/10.3390/jrfm13100238

27. Kuzior, A., Arefieva, O., Kovalchuk, A., Brożek, P., & Tytykalo, V. (2022). Strategic guidelines for the intellectualization of human capital in the context of innovative transformation. *Sustainability, 14*(19), Article 11937. https://doi.org/10.3390/su141911937

28. Kuzior, A., Liakisheva, A., Denysiuk, I., Oliinyk, H., & Honchar, L.

(2020). Social risks of international labour migration in the context of global challenges. *Journal of Risk and Financial Management, 13*(9), Article 197. https://doi.org/10.3390/jrfm13090197

29. Kuzior, A., Ober, J., & Karwot, J. (2021). Stakeholder expectation of corporate social responsibility practices: A case study of PWiK Rybnik, Poland. *Energies, 14*(11), Article 3337. https://doi.org/10.3390/en14113337

30. Litovtseva, V., Krawczyk, D., Kuzior, A., Brychko, M., & Vasylieva, T. (2022). Marketing research in the context of trust in the public sector: A case of the digital environment. *Innovative Marketing, 18*(4), 133-147. https://doi.org/10.21511/im.18(4).2022.12

31. Lyeonov, S., Tiutiunyk, I., Vasekova, M., Dziubenko, O., & Samchyk, M. (2022). Tax, investment, institutional and social channels of economic shadowing: Challenges for macrofinancial stability and good governance. *Public and Municipal Finance, 11*(1), 128-141. https://doi.org/10.21511/pmf.11(1).2022.11

32. Mason-D'Croz, D., Bogard, J. R., Sulser, T. B., Cenacchi, N., Dunston, S., Herrero, M., & Wiebe, K. (2019). Gaps between fruit and vegetable production, demand, and recommended consumption at global and national levels: An integrated modelling study. *The Lancet. Planetary Health, 3*(7), e318-e329. https://doi.org/10.1016/S2542-5196(19)30095-6

33. Muharremi, O., Salé, M. J., & Hoxhaj, M. (2022). A mixed-methods study of the influence of demographic factors on Albanian individual taxpayers' ethical beliefs surrounding tax compliance. *Business Ethics and Leadership, 6*(1), 47-66. http://doi.org/10.21272/bel.6(1).47-66.2022

34. Mullens, D., & Shen, S. (2023). Sustainable and entrepreneurial: A path to performance improvements for family firms? *SocioEconomic Challenges, 7*(4), 54-65. https://doi.org/10.61093/sec.7(4).54-65.2023

35. Nilsson, E., Becker, P., & Uvo, C. B. (2020). Drivers of abrupt and gradual changes in agricultural systems in Chad. *Regional Environmental Change, 20,* Article 75. https://doi.org/10.1007/s10113-020-01668-9

36. Niyaz, A. M., & Allahverdi, L. J. (2023). Medición del nivel de intervención estatal (apoyo) en la pro-ducción agrícola [Measuring the level of state intervention (support) in agricultural production]. *Universidad y Sociedad, 15*(2), 18-26. (In Spanish). Retrieved from http://scielo.sld.cu/scielo.php?pid=S2218-36202023000200018&script=sci_arttext

37. Orlov, V., Bukhtiarova, A., Marczuk, M., & Heyenko, M. (2021). International economic and social determinants of the state economic security: A causal analysis. *Problems and Perspectives in Management, 19*(4), 301-310. https://doi.org/10.21511/ppm.19(4).2021.24

38. Oussou, K. F., Guclu, G., Kelebek, H., & Selli, S. (2023). Valorization of cocoa, tea and coffee processing by-products-wastes. In E. Capanoglu, M. D. Navarro-Hortal, T. Y. Forbes-Hernández, & M. Battino (Eds.), *Advances in Food and Nutrition Research* (pp. 91-130). Academic Press. https://doi.org/10.1016/bs.afnr.2023.03.003

39. Pakhnenko, O., & Kuan, Z. (2023). Ethics of digital innovation in public administration. *Business Ethics and Leadership, 7*(1), 113-121. https://doi.org/10.21272/bel.7(1).113-121.2023

40. Rakotoarisoa, M. A., & Mapp, H. P. (2023). A non-parametric approach to determine an efficient premium for drought insurance. *SocioEconomic Challenges, 7*(1), 1-14. https://doi.org/10.21272/sec.7(1).1-14.2023

41. Ramli, M., Boutayeba, F., & Nezai, A. (2022). Public investment in human capital and economic growth in Algeria: An empirical study using ARDL approach. *SocioEconomic Challenges, 6*(2), 55-66. https://doi.org/10.21272/sec.6(2).55-66.2022

42. Richardson, K. (2023). Beekeeping role in enhancing food security and environmental public health. *Health Economics and Management Review, 4*(4), 69-79. https://doi.org/10.61093/hem.2023.4-06

43. Romenska, K., Datsenko, V., Samoday, V., Puhach, Y., & Dudchyk, O. (2024). Management of budget flows under martial law. *Public and Municipal Finance, 13*(1), 55-69. https://doi.org/10.21511/pmf.13(1).2024.05

44. Serkendiz, H., Tatli, H., Özcan, H., Çetin, M., & Sungur, A. (2023). Multidimensional assessment of agricultural drought vulnerability based on socioeconomic and biophysical indicators. *International Journal of Disaster Risk Reduction, 98,* Article 104121. https://doi.org/10.1016/j.ijdrr.2023.104121

45. Shi, Y., Osewe, M., Anastacia, C., Liu, A., Wang, S., & Latif, A. (2023). Agricultural supply-side structural reform and path optimization: Evidence from China. *International Journal of Environmental Research and Public Health, 20*(1), Article 113. https://doi.org/10.3390/ijerph20010113

46. Shynkaruk, L., Dielini, M., Vlasenko, T., Svyrydenko, D., & Lagodiienko, V. (2023). Determinants of Ukrainian economic and food security development under the conditions of martial law. *Financial and Credit Activity Problems of Theory and Practice, 4*(51), 311-319. https://doi.org/10.55643/fcaptp.4.51.2023.4120

47. Singh, S. N. (2022). Coffee value chain in Ethiopia: A case study. *Financial Markets, Institutions and Risks, 6*(4), 76-100. https://doi.org/10.21272/fmir.6(4).76-100.2022

48. Singh, S. N., & Pandey, A. (2023). Accomplishing Sustainable Development Goals in India: A systematic literature review. *Financial Markets, Institutions and Risks, 7*(2), 80-87. https://doi.org/10.21272/fmir.7(2).80-87.2023

49. Sporchia, F., Taherzadeh, O., & Caro, D. (2021). Stimulating environmental degradation: A global study of resource use in cocoa, coffee, tea and tobacco supply

chains. *Current Research in Environmental Sustainability,* 3, Article 100029. https://doi.org/10.1016/j.crsust.2021.100029

50. Thiam, I., & Toure, M. (2020). Empirical links between agricultural finance and food security in Senegal. *African Journal of Agricultural and Resource Economics, 15*(4), 311-324. Retrieved from https://afjare.org/liens-empiriques-entre-financement-agricole-et-securite-alimentaire-au-senegal/
51. Tiutiunyk, I. V., Zolkover, A. O., Lyeonov, S. V., & Ryabushka, L. B. (2022). The impact of economic shadowing on social development: Challenges for macroeconomic stability. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu, 2022*(1), 183-191. https://doi.org/10.33271/nvngu/2022-1/183
52. Toledo, L., Salmoral, G., & Viteri-Salazar, O. (2023). Rethinking agricultural policy in Ecuador (1960–2020): Analysis based on the water–energy–food security nexus. *Sustainability, 15*(17), Article 12850. https://doi.org/10.3390/su151712850
53. Tu, Y-X., Kubatko, O., Piven, V., Kovalov, B., & Kharchenko, M. (2023). Promotion of sustainable development in the EU: Social and economic drivers. *Sustainability, 15*(9), Article 7503. https://doi.org/10.3390/su15097503
54. United Nations. (2015). *Resolution adopted by the General Assembly on 25 September 2015, Transforming our world: The 2030 Agenda for Sustainable Development, A/RES/70/1.* Retrieved from https://sdgs.un.org/2030agenda
55. Wang, W., Wei, K., Kubatko, O., Piven, V., Chortok, Y., & Derykolenko, O. (2023). Economic growth and sustainable transition: Investigating classical and novel factors in developed countries. *Sustainability*, *15*(16), Article 12346. https://doi.org/10.3390/su151612346
56. World Bank. (n.d.). *Indicators*. Retrieved from https://data.worldbank.org/indicator
57. Yerankin, O., Ivasiv, I., Oleksiuk, O., Ovsiienko, N., & Parii, L. (2023). Formation of a set of national food security indicators. *Financial and Credit Activity Problems of Theory and Practice*, *2*(49), 457-468. https://doi.org/10.55643/fcaptp.2.49.2023.3986
58. Zolkover, A., Tiutiunyk, I., Babenko, V., Melnychuk, M., Ivanchenkova, L., & Lagodiienko, N. (2022). The quality of tax administration, macroeconomic stability and economic growth: Assessment and interaction. *Review of Economics and Finance, 20,* 654-661. https://doi.org/10.55365/1923.x2022.20.76

http://dx.doi.org/10.21511/ppm.22(2).2024.38

APPENDIX A

Table A1. Grouping of countries by GDP per capita

GDP per capita (current US$)		
<20,000	**20,000-50,000**	**>50,000**
Poland, Croatia, Hungary, Romania, Bulgaria, Turkey, Montenegro, Serbia, Azerbaijan, Bosnia and Herzegovina, Armenia, Albania, Georgia, North Macedonia, the Republic of Moldova, Ukraine	Belgium, Germany, the United Kingdom, France, Italy, Spain, Slovenia, Estonia, the Czech Republic, Lithuania, Portugal, Latvia, Slovakia, Greece	Luxembourg, Norway, Ireland, Switzerland, Denmark, the Netherlands, Sweden, Austria, Finland