

MODELING HUMAN SOCIAL SECURITY DURING WAR

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This paper explores the impact of economic and social policy on the life expectancy at birth as it determines the human social security in the country, reflecting the level of life support, well-being, social protection and self-preservation, as well as the level of education and self-development. We identified a certain “trap of social insecurity”, when a low level of income in the country leads to the degradation of human capital, a decrease in life expectancy due to the lack of adequate social protection that may ultimately lead to the slowdown in economic development. This mechanism of maintaining social insecurity significantly accelerates during military conflicts. From the cluster analysis, we can conclude that hybrid wars do not have a noticeable effect on the average life expectancy of the population. The empirical results of the panel VAR model showed slight response of life expectancy to economic and social policy shocks in Armenia, Azerbaijan, Georgia, Moldova and Ukraine – countries that are the victims of either hybrid wars or full-scale hostilities on the territory of the former USSR. The most significant effect on life expectancy is exerted by the growth of gross domestic product per capita. Current health expenditure per capita shocks have a small positive effect on life

expectancy in the short run. On the other hand, unemployment and the factor of hybrid wars and military conflicts have a slight negative impact in the short term. In the long run, all the above impacts are leveled off. At the same time, the results of decomposition of the variance of the forecast errors of life expectancy at birth showed that its volatility is largely explained by the inherent fluctuations of this indicator. The variation of gross domestic product per capita explains about 9% of the variation in life expectancy at birth in the selected countries, unemployment – slightly more than 2%.

Keywords: *social security, economic development, life expectancy at birth, cluster analysis, self-organizing map, panel VAR model*

JEL Classification C33, C38, C5, H55, H56, I15

1. Introduction

Social security is considered an important factor of the economic system stability and an integral element in building a civil society. The human social security deals with the protection of its vital socio-economic interests, rights and values from internal and external threats. At the macro level, it stimulates the economic development of the country due to the increase in the well-being of its population, the “cushioning the effects of structural and technological change” [7], and social tensions in society. At the same time, the human social security reflects the level of social relations and culture in society. At micro level, social security covers various types of social assistance to individuals and households, guaranteed income after retirement, educational opportunities, etc. However, in the conditions of war, the aspects of protection and self-preservation of a person should come to the fore, but in the post-war period — the issue of restoration and acceleration of economic development.

It is worth noting that the indicative system of human social security largely determines the level of economic development. For instance, the group of indicators characterizing the level of human life support includes life expectancy at birth, which directly affects the economic development of the national economy, primarily the human development index. The key indicator characterizing the level of well-

being is the gross domestic product per capita. However, in the conditions of military aggression, indicators characterizing the level of protection and self-preservation come to the fore, in particular, the personnel of the armed forces, military expenditures, the number of refugees and internal displacements related to conflict and violence [2].

So, it is relevant to study human social security as the main source of society's development based on the application of economic and mathematical models, which will allow identification, forecasting and timely response to the appearance of the threats to life and human development.

The purpose of this paper is to shed light on the factors affecting the human social security during the wars. The paper is organized in the following way. The Introduction presents the topicality of the study. In Chapter 2, we conduct overview of the literature on the topic of economic and social security. Chapter 3 describes the theoretical background of the study. Chapter 4 is devoted to the estimation and results of applying cluster analysis and panel VAR model. The final chapter gives some conclusions and possible directions for further research.

2. Literature overview

A wide range of economic and mathematical methods is used in studies of social security and its components. Papers on this topic could be divided on those that are devoted to the assessment of the social security's level and ones that address its modeling.

The issue of assessing the social security is highlighted in a number of publications. Thus, Kharazishvili and Grishnova in [8, 9] consider the level of poverty as the main indicator of quality of life. The authors proposed a methodology to estimate the level of society's social security based on a system of indicators determined by three components of social safety – standard of living, demographic component, and quality of life. Moreover, Kharazishvili and Dron' [10] propose a methodology for measuring the level of economic security based on normalized and threshold values of indicators.

Sydorchuk [20] carries out an integral assessment of social security of Ukraine based on the formation of seven sub-indices, including material well-being, employment, social and labor relations, demographic situation, health safety, safety and threats to life, social protection, social isolation and deviant behavior, and social well-being in society. In the paper [1] authors developed a social security index that includes composite financial risk, composite labour risk, unemployment, and composite social risk to point out tipping points that have impact on economic policy in the context of social security. Paraschiv et al. in [18] proposed the Social Inclusion Index, which is an aggregated indicator that incorporates not only GDP, but also factors related to civil and political rights, women's rights etc.

In the paper [19] relationship between social security expenditure and the Human Common Development Index is examined. In addition, authors of [2] calculated an indicator of the human social security based on a system of indices, which includes five groups of indicators characterizing the levels of life support, well-being, social protection, protection and self-preservation, and the level of education and self-development. The dynamics of this integrated indicator showed that despite the hybrid war, an improvement of human social security was observed in Ukraine during 2014-2020.

Another set of papers is devoted to the formation of social security policy using model-based and statistical tools. For instance, Korzeniowska [13] for the purpose of study the level of social expenditures in the EU uses the clustering methods to divide countries into homogeneous groups. The results of the research prove that while shaping the social policy the EU countries should take into account cultural and social peculiarities. In the paper [12], the clustering approach was used to segment a number of sectors of the Ukrainian economy based on a set of socio-economic indicators with the aim of subsequently predicting their development in the context of digitalization and its impact on the social security of workers in these sectors, primarily employment.

Forni [5] uses overlapping generations model with short lived governments with a focus on the welfare of young generations to extend similar studies with the simple intergenerational games in

direction of finding the Markov perfect equilibria of the social security policy game. In turn, Gonzalez-Eiras [6] extends these results [5] for the case of logarithmic utility to derive (under some restriction) the globally well defined equilibrium with a stable dynamics. Lopez-Velasco [14] also explores OLG models with logarithmic utility under Markovian strategies to study the politico-economic sustainability of pay-as-you-go social security. It is shown that equilibria with social security exists only if the economy is dynamically inefficient.

Paper [15] shows that such an economy can function effectively by reducing capital per worker with the help of foreign guest workers that increases the welfare of generations under Markov and under trigger strategies. Moreover, the Markov switching models have been developed to model the asymmetry in the unemployment rate of the labor market in a number of European countries such as Bulgaria, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Ukraine [16, 17].

Fehr [4] models the impact of the demographic transition on international capital markets and national wages using the computable general equilibrium model with subsequent defining the optimal funding and progressivity of social security.

A number of papers, for instance [3, 23, 24], devoted to the study of optimal pay-as-you-go social security with the help of dynastic family model. In [24], authors Zhang and Zhang enhanced the model with investment externalities, positive bequests and endogenous fertility. As a result, they obtained that optimal social security would improve welfare while reducing fertility and increasing capital intensity. Yew and Zhang in [23] incorporated human capital externalities, fertility and endogenous growth in a dynastic family model and showed that social security will enhance the welfare not only by reducing fertility, but also by rising the human capital investment per child.

Thus, literature review shows that the issue of examining the impact of public policy on social security under conditions of military conflicts and hybrid wars remains unsolved, which makes such research so important and relevant.

3. Theoretical Background

Life expectancy at birth characterizes the level of social security of a person, which reflects the level of life support, well-being, social protection and self-preservation, the level of education and self-development, which, in turn, affects the pace of economic development. At the same time, the economic development of the country can have a negative impact on the life expectancy of the population if it is not reinforced by social progress. Moreover, it can be argued that life expectancy at birth reflects not only the level of human social security, but also the overall level of development of society. In addition, life expectancy at birth is affected by relevant government economic and social policies, as well as the presence of internal and external military conflicts and hybrid wars. Life expectancy varies widely around the world, ranging from 52.5 years in Chad to 85.5 years in Hong Kong [21].

First of all, we will group countries according to the level of life expectancy at birth to identify their common properties and general patterns. To do this, we use a clustering approach, which allows us to divide countries into groups based on similar values of their social security features. For this purpose, we use the most common clustering method – k-means.

A preliminary analysis of life expectancy at birth in 209 countries in 2021, based on data from [21], revealed the presence of four clusters. Applying the k-means method made it possible to determine the centers of these clusters at 54.21, 63.40, 73.73 and 82.31 years and the composition of the countries included in them (results of clustering are presented in Table 1).

The first cluster includes 7 African countries with the lowest average life expectancy – 54.21 years, most of which are low-income [22] with ongoing military conflicts. The second cluster, centered at 63.40 years, covers 58 countries (mostly lower-middle income countries), including mainly African and some Asian countries, the largest of which is India. The vast majority of countries with upper-middle income belong to the cluster with an average life expectancy of 73.73 years (107 countries worldwide). 37 high-income countries are in the fourth cluster with the highest life expectancy at birth, averaging 82.31 years.

Table 1

**RESULTS OF THE CLUSTERING OF COUNTRIES WORLDWIDE
BY LIFE EXPECTANCY AT BIRTH IN 2021**

Cluster	Cluster center	Number of objects in cluster	Countries
1	54.21	7	Central African Rep., Chad, Eswatini, Lesotho, Nigeria, Somalia, South Sudan
2	63.40	58	Afghanistan, Angola, Benin, Bolivia, Botswana, Burkina Faso, Burundi, Cameroon, Comoros, Congo Dem. Rep., Congo Rep., Cote d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Fiji, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Guyana, Haiti, India, Indonesia, Kenya, Kiribati, Lao PDR, Liberia, Madagascar, Malawi, Mali, Marshall Islands, Mauritania, Moldova, Mozambique, Myanmar, Namibia, Nauru, Nepal, Niger, Pakistan, Papua New Guinea, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Timor-Leste, Togo, Tuvalu, Uganda, Yemen, Zambia, Zimbabwe
3	73.73	107	Albania, Algeria, Antigua and Barbuda, Argentina, Armenia, Aruba, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belize, Bermuda, Bhutan, Bosnia and Herzegovina, Brazil, British Virgin Islands, Brunei Darussalam, Bulgaria, Cabo Verde, Cambodia, Chile, China, Colombia, Costa Rica, Croatia, Cuba, Czech Rep., Dem. People's Rep. of Korea, Dominica, Dominican Rep., Ecuador, Egypt, El Salvador, Estonia, French Polynesia, Georgia, Gibraltar, Greenland, Grenada, Guam, Guatemala, Honduras, Hungary, Iran Islamic Rep., Iraq, Jamaica, Jordan, Kazakhstan, Kosovo, Kuwait, Kyrgyz Rep., Latvia, Lebanon, Libya, Lithuania, Malaysia, Maldives, Mauritius, Mexico, Micronesia, Mongolia, Montenegro, Morocco, New Caledonia, Nicaragua, North Macedonia, Oman, Panama, Paraguay, Peru, Philippines, Poland, Qatar, Romania, Russian Federation, Samoa, Saudi Arabia, Serbia, Seychelles, Sint Maarten (Dutch part), Slovak Rep., Solomon Islands, Sri Lanka, St. Kitts and Nevis, St. Lucia,

			St. Vincent and the Grenadines, Suriname, Syrian Arab Rep., Tajikistan, Thailand, Tonga, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Turks and Caicos Islands, Ukraine, United Arab Emirates, United States, Uruguay, Uzbekistan, Vanuatu, Venezuela, Vietnam, West Bank and Gaza
4	82.31	37	Faroe Islands, Finland, France, Germany, Greece, Hong Kong SAR (China), Iceland, Ireland, Isle of Man, Israel, Italy, Japan, Korea Rep., Liechtenstein, Luxembourg, Macao SAR (China), Malta, Netherlands, New Zealand, Norway, Portugal, Puerto Rico, Singapore, Slovenia, Spain, St. Martin (French part), Sweden, Switzerland, United Kingdom, Virgin Islands (U.S.)

Thus, we could identify the existence of a certain “trap of social insecurity”, when a low level of income in the country leads to the degradation of human capital and decrease in life expectancy due to the lack of adequate social protection that may ultimately lead to the slowdown in economic development and further decline in income levels. This mechanism of maintaining social insecurity significantly accelerates during military conflicts.

In this paper, we are making an attempt to empirically study the influence of public economic and social policies aimed at increasing life expectancy and, accordingly, the level of human social security in countries that are victims of both hybrid wars and full-scale hostilities on the territory of the former USSR. These are Armenia, Azerbaijan, Georgia, Moldova, and Ukraine.

The conflict between Armenia and Azerbaijan, which is based on ethnic and territorial disputes, has been going on since 1988 until now (in certain periods it was marked by military actions, in others by border clashes). The Transnistrian conflict between the Republic of Moldova and the self-proclaimed Transnistrian Moldavian Republic has also been ongoing since the early 1990s, but now it is characterized by the features of a hybrid war. The Russian-Georgian hybrid war began in 1992. Also, direct Russian military aggression lasted for 5 days in August 2008. In Ukraine, despite the fact that the full-scale Russian-Ukrainian war has been going on since February 2022, the hybrid war began in 2014.

The dynamics of life expectancy in these countries during 1991-2021 according to World Bank data [21] are shown in Fig. 1.

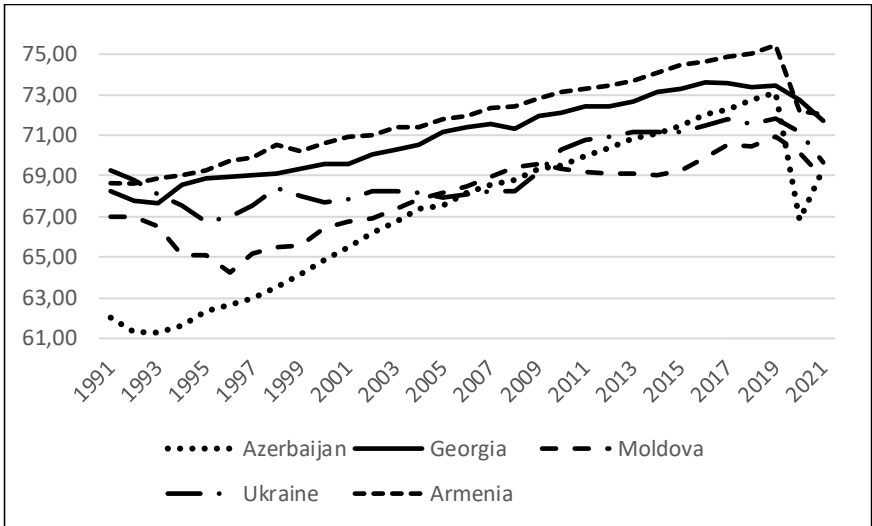


Fig. 1. Dynamics of life expectancy at birth during 1991-2021

As can be seen in Fig. 1, in 1991 Ukraine had the highest life expectancy among five countries – 69.3 years, in 2021 – 69.65 years (the highest life expectancy in 2021 was recorded in Armenia – 72.04 years, and the lowest in Moldova – 68.85 years). Note that the decrease in life expectancy in all countries in 2020 is due to Covid-19.

4. Results

To justify the relationship between life expectancy at birth in Armenia, Azerbaijan, Georgia, Moldova and Ukraine and factors reflecting the public economic and social policy the following indicators were used: GDP per capita, current health expenditure per capita, military expenditure, public expenditure on education, armed forces personnel, and social contributions. In addition, we considered

such variables, as domestic credit to private sector by banks, inflation and unemployment. To account for periods of hybrid wars and military conflicts we applied a dummy variable.

Thus, a panel data set covers five cross-sections (Armenia, Azerbaijan, Georgia, Moldova and Ukraine) and 21 observation periods (from 2000 to 2020). The information source of the research is the annual data of World Development Indicators [21] of the World Bank.

A description of the variables used to examine the relationship between life expectancy and indicators characterizing economic and social policies in countries engaged in hybrid wars and full-scale hostilities is presented in Table 2.

Table 2

DESCRIPTION OF VARIABLES

Variable	Description
L_t	Life expectancy at birth, total (years)
F_t	Armed forces personnel (% of total labor force)
GDP_t	GDP per capita (PPP, current US dollars)
H_t	Current health expenditure per capita (current US dollars)
CR_t	Domestic credit to private sector by banks (% of GDP)
INF_t	Inflation, consumer prices (annual %)
ME_t	Military expenditure (% of GDP)
E_t	Public expenditure on education (% of GDP)
U_t	Unemployment, total (% of total labor force)
CTR_t	Social contributions (% of revenue)
W_t	Dummy variable indicating periods when hybrid wars and military aggressions occur

Descriptive statistics of the mentioned above variables are given in Table 3.

Table 3

DESCRIPTIVE STATISTICS OF CHOSEN VARIABLES

Variable	Mean	Median	Min	Max	St. dev.	Variation	Asymmetry	Kurtosis
L_t	70.54	70.88	64.89	75.44	2.28	0.03	-0.14	-0.58
F_t	1.75	1.60	0.56	3.82	0.92	0.52	0.87	-0.36
GDP_t	2970.30	2606.20	1249.60	5506.20	1189.40	0.40	0.68	-0.65
H_t	192.46	186.67	18.98	551.54	121.21	0.63	0.51	-0.08
CR_t	28.90	25.12	5.19	76.78	17.41	0.60	0.71	-0.22
INF_t	7.11	5.30	-1.40	48.70	7.12	1.00	2.71	11.22
ME_t	2.58	2.47	0.26	9.16	1.69	0.66	0.85	1.85
E_t	4.15	3.29	1.91	9.51	1.79	0.43	0.77	-0.46
U_t	9.47	9.17	2.91	20.71	3.97	0.42	0.83	0.52
CTR_t	17.39	15.45	0.00	37.88	13.01	0.75	0.01	-1.45
W_t	0.87	1.00	0.00	1.00	0.34	0.39	-2.16	2.65

In order to identify general patterns of development and similarities in the data structure of the five selected countries, first of all, we will conduct a cluster analysis of the generalized characteristic of life expectancy at birth based on a set of 10 remaining explanatory variables from Table 2 for the period under study – from 2000 to 2020. For this purpose, it was decided to use the Kohonen self-organizing maps toolkit [11], which, in addition to solving the tasks of reducing dimensionality in complex data sets and forming homogeneous groups of studied objects, provide an opportunity for visual analysis of clustering results [12]. Kohonen maps are unique in that the location of an object on the map allows us to determine how developed the feature under study is (in our task, life expectancy at birth), based on a variety of characteristic indicators, compared to other objects.

Based on the data for 10 explanatory variables from Table 2 for the 21-year observation period from 2000 to 2020, clustering of the countries Armenia, Azerbaijan, Georgia, Moldova and Ukraine was

carried out. Note that the life expectancy indicator was not used during clustering – it acted only as an auxiliary guide (some analogue of the resulting variable). The clustering process involved 5000 training epochs. A Gaussian function was chosen to determine the neighborhood of neurons. As a result of the experiments, the optimal structure of the self-organizing map was determined to be a hexagonal grid with the size of 16×12 neurons, on which the distribution of countries among six clusters was obtained, as can be seen in Fig. 2.

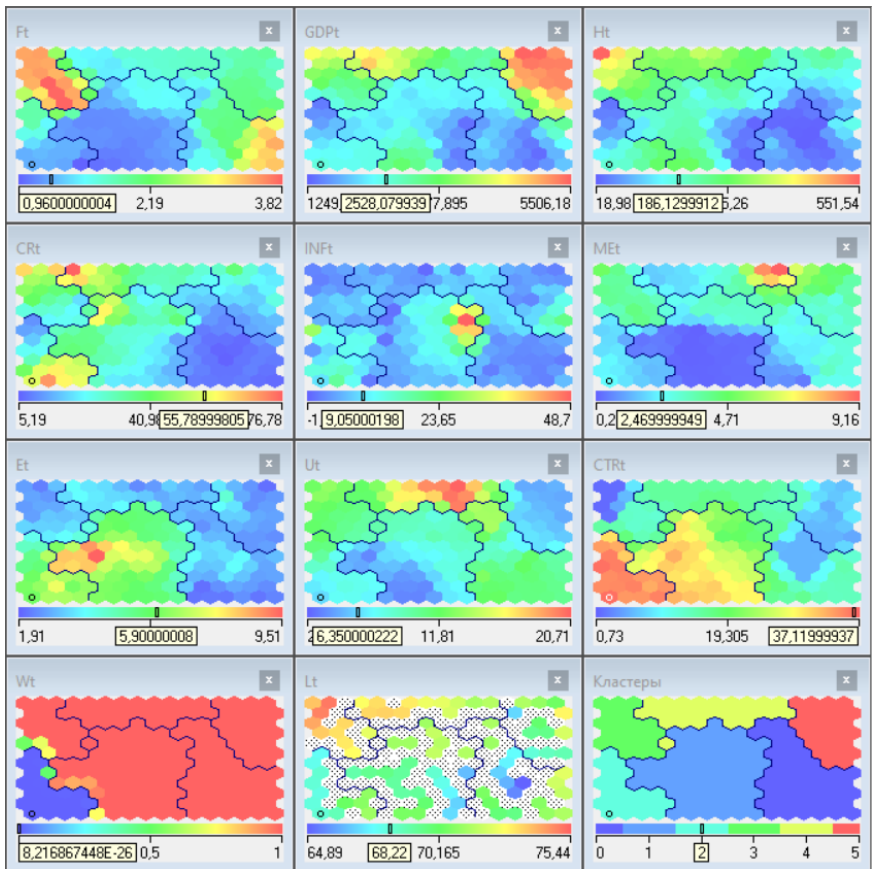


Fig. 2. Clustering of five countries on features characterizing life expectancy at birth for the period 2000-2020

By the color of the cluster on the map image in the lower right corner of Fig. 2, you can determine its number using the colored ruler under the map. For example, the cyan cluster in the lower left corner has the number 2. It is occupied by observations for Ukraine from 2000 to 2013. This isolated position of the country in this time interval is explained by the lower left image in Fig. 2, in which the dummy variable W_t indicates periods when hybrid wars and military aggressions occur.

Since hostilities began before 2000 in 4 other countries and conflicts of varying intensity continue, the dummy variable for the presence of military conflicts for all these countries has a value of 1 throughout the study period from 2000 to 2020. Ukraine was subjected to Russian aggression in 2014, after which the conflict has not stopped. Therefore, the dummy variable W_t takes the value 1 since 2014, and before 2013 it had the value 0. All other observations for Ukraine from 2014 to 2020 are grouped in the neighboring first cluster together with all records for Moldova.

The peculiarity of these two clusters is high levels of public expenditures on education E_t and social contributions CTR_t , above average consumer price inflation INF_t and low unemployment rate U_t . Moldova also has the lowest military expenditures relative to GDP ME_t and personnel of the armed forces relative to the total workforce F_t among all other countries. At the same time, the life expectancy L_t in these two clusters is somewhere at an average level throughout the entire observation period.

The third cluster in the upper left corner, characterized by the highest percentage of personnel of the armed forces relative to the total workforce F_t , includes Armenia from 2008 to 2020. It should be noted that Ukraine does not have such high values for this indicator, since the active phase of the war with a significant increase in the number of armed forces began in 2022, which was not included in the studied dataset. Also, the third cluster is characterized by a high value of current health expenditures per capita H_t with low social contributions CTR_t and the highest life expectancy at birth L_t among all clusters.

The remaining records for Armenia, together with observations for Azerbaijan and Georgia at the beginning of the 2000s, fell into the

zero cluster, which is characterized for all three countries by a fairly high level of personnel of the armed forces F_t , an average unemployment level U_t , and quite low values of all other indicators at the beginning of this century, including cluster-averaged life expectancy L_t (although it differs for the three countries that fell into this cluster).

Since 2006, Azerbaijan has moved to the fifth cluster in the upper right corner of the map, which is characterized primarily by the highest value of GDP per capita GDP_t . It should be noted that the jump in GDP growth is associated with a sharp increase in revenues from oil sales. This cluster is also characterized by average values of militarization indicators – F_t and ME_t , and low values of all other indices. Simultaneously with the growth of GDP, there was a significant increase in life expectancy of the population.

Georgia has moved to the fourth cluster since 2007, which is characterized by the highest levels of military expenditures ME_t , domestic credit to the private sector by banks CR_t and unemployment U_t among other clusters. Life expectancy L_t here is very high – in second place after the third cluster, but all other indicators are at the average level and below.

From the cluster analysis, we can conclude that life expectancy at birth is most strongly affected by economic development, in particular GDP per capita. Hybrid wars do not have a noticeable effect on the average life expectancy of the population. Most likely, full-scale hostilities will show an inverse relationship, but in the analyzed countries there were no such military conflicts in the period 2000-2020. This can be further analyzed when statistics for Ukraine from 2022 onwards become available.

To study the impact of public economic and social policy on life expectancy at birth in the 5 countries under study, a panel vector autoregressive model (panel VAR model) was constructed:

$$Y_t = A_0 + A_1 Y_{t-1} + \varepsilon_t, \quad t = \overline{1, T}, \quad (1)$$

where Y_t is a vector of variables $(\Delta L_t, \Delta F_t, \Delta GDP_t, \Delta H_{t-1}^1, \Delta CR_t, \Delta E_t, \Delta U_t, W_t)$ of all n countries in the t -th period, n indicates number of

¹ Current health expenditure per capita is with index $t - 1$ due to Granger causality test.

cross-sections (5 analyzed countries – Armenia, Azerbaijan, Georgia, Moldova and Ukraine), T is the number of years, for which the forecast is made (in our study, this is 19 periods from 2002 to 2020, taking into account one year 2001 for input factors plus one more 2000 for ΔH_{t-1}), A_0 is a vector of intercepts (constants), A_1 is a matrix of coefficients, and ε_t – vector of disturbances.

Note, that variable ΔCTR_t was excluded from the list of influencing factors due to the fact that it led to multicollinearity. Most of the variables are the first order integrated (levels of these variables have the unit root, but their first differences are stationary), so in the model (1) we used their first differences, denoted by Δ . The number of lags (the order of the panel vector autoregressive model) is determined based on the minimization of the Akaike, Schwartz, and Hannan-Quinn information criteria. The constructed model can be checked for stationarity by finding the inverse roots of the characteristic polynomial.

Based on the constructed panel VAR model, we examine the reaction of life expectancy at birth in Armenia, Azerbaijan, Georgia, Moldova and Ukraine to shocks in public economic and social policy. In particular, we will analyze the impulse response functions (see Fig. 3, where the variables are ordered by response magnitude) and the forecast error variance decomposition of life expectancy at birth (Table 4).

According to the impulse response functions in Fig. 3, it is necessary to state a slight reaction of life expectancy at birth to economic and social policy shocks for all cross-sections (countries) in a whole. Commenting on the response of life expectancy at birth ΔL_t to the shock in gross domestic product ΔGDP_{t-j} , we observe a slight increase in ΔL_t (in all graphs x-axis shows the periods j of changes in the influencing factor, y-axis – percent of a change of life expectancy at birth ΔL_t). So, in the first period, that is a year after the shock in ΔGDP_{t-1} , impulse response function demonstrates a rise of life expectancy at birth ΔL_t up to 0,011%, but this increase levels off in the 3rd period after the shock. Shock in public expenditure on education ΔE_{t-1} produces up to 0,004% increase in life expectancy at birth in the first period following the shock. Nevertheless, as with the impact of the shock of the gross domestic product ΔGDP_{t-3} , we observe the levelling of this increase till the 3rd period. On the other

hand, unemployment ΔU_{t-j} has a slight negative effect in the short run (up to first three periods). In the long term (here till the tenth period), all of the above impacts are leveled off. Public expenditure on education ΔF_{t-j} shock has no influence on life expectancy at birth ΔL_t . Current health expenditure per capita shock ΔH_{t-1-j} have a small short run positive effect on life expectancy at birth ΔL_t , as we observe a negligible upturn in the second period following the shock.

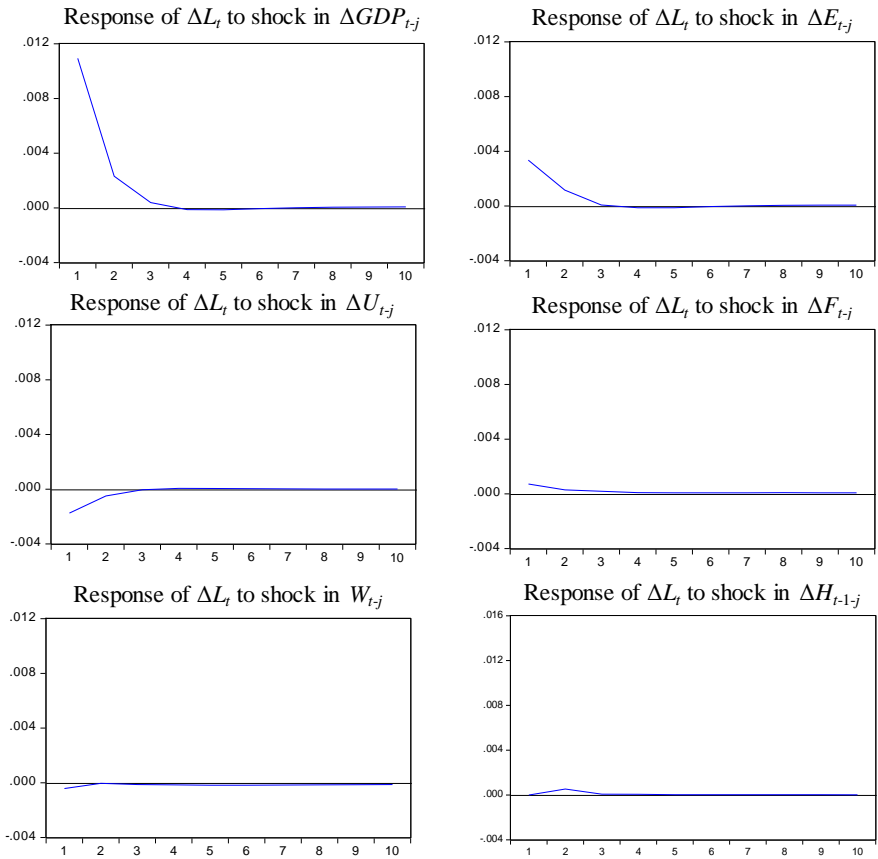


Fig. 3. Impulse response functions of life expectancy at birth to shocks in economic and social policies

The shock in hybrid wars and military conflicts W_{t-j} provokes a slight decrease of life expectancy at birth ΔL_t in one period after the shock. Thus, the most significant impact on life expectancy at birth ΔL_t comes from the positive effect of gross domestic product per capita ΔGDP_{t-j} shock.

The forecast error variance decomposition indicates the amount of information that each variable contributes to the other variables in the autoregression. The results of the variance decomposition demonstrate that volatility of life expectancy at birth ΔL_t is largely explained by its own fluctuations at almost 85% (see Table 4).

Table 4

THE RESULTS OF FORECAST ERROR VARIANCE DECOMPOSITION
OF LIFE EXPECTANCY AT BIRTH

Period <i>j</i>	S.E.	Share of the total forecast error variance (% of S.E.)								
		ΔL_{t-j}	ΔGDP_{t-j}	ΔF_{t-j}	$\Delta H_{t-1,j}$	ΔE_{t-j}	ΔU_{t-j}	ΔCR_{t-j}	W_{t-j}	
1	0.1228	84.7459	8.3013	0.0273	0.0149	4.1614	2.1735	0.4459	0.1297	
2	0.1479	82.9272	8.7203	0.0329	0.1845	5.3428	2.2014	0.4680	0.1230	
3	0.1655	82.8500	8.7074	0.0516	0.2341	5.3330	2.1981	0.4906	0.1351	
4	0.1814	82.8167	8.7131	0.0581	0.2376	5.3307	2.1992	0.4917	0.1529	
5	0.1899	82.7853	8.7175	0.0634	0.2375	5.3301	2.1996	0.4915	0.1751	
6	0.1933	82.7627	8.7158	0.0674	0.2379	5.3288	2.1998	0.4914	0.1963	
7	0.1944	82.7431	8.7140	0.0708	0.2383	5.3276	2.1995	0.4912	0.2154	
8	0.1947	82.7250	8.7139	0.0739	0.2385	5.3264	2.1991	0.4911	0.2321	
9	0.1947	82.7082	8.7148	0.0767	0.2386	5.3253	2.1986	0.4910	0.2467	
10	0.1948	82.6931	8.7162	0.0793	0.2386	5.3243	2.1981	0.4909	0.2595	

Thus, the variation of gross domestic product per capita ΔGDP_{t-j} explains almost 9% of the variation in life expectancy at birth ΔL_t for ten periods ahead (from 8.3013 in the 1st period to 8.7162 in the 10th period). Public expenditure on education ΔE_{t-j} contributes about 5% to the variation in life expectancy at birth

ΔL_t (from 4.1614 to 5.3243). The maximum value of the variation in life expectancy at birth ΔL_t due to public expenditure on education ΔE_{t-j} (5.3428) is observed in the 2nd period. Unemployment ΔU_{t-j} contributes slightly more than 2% (from 2.1735 to 2.1981) with the highest value of 2.2014 in the 2nd period. The influence of other factors is less than 1%.

Conclusions

In conditions of a hybrid war and military aggression the problems of human survival and protection come to the fore, so the issue of forming an appropriate system of ensuring human social security, its permanent monitoring and analysis becomes an urgent and important problem. As a result, one of the main tools for studying human social security is economic and mathematical modeling, which allows to evaluate, identify, forecast threats to human life and development and, hence, respond to their appearance in time. The level of human social security in a country can be measured on the basis of life expectancy at birth, which comprehensively reflects the level of development of society.

We have identified the existence of a certain “trap of social insecurity”, when a low level of income in the country leads to the degradation of human capital, a decrease in life expectancy due to the lack of adequate social protection that may ultimately lead to the slowdown in economic development and further decline in income levels. This mechanism of maintaining social insecurity is significantly accelerated during military conflicts.

Therefore, as human social security is the key to long-term economic growth under the condition of resistance to adverse disturbances, in the paper we have made an attempt to study the impact of indicators reflecting changes in state policy aimed at increasing life expectancy at birth in countries that were victims of hybrid wars and full-scale hostilities (Armenia, Azerbaijan, Georgia, Moldova and Ukraine), based on the application of econometric tools and cluster analysis.

The clustering was carried out using the Kohonen self-organizing map toolkit, which made it possible to identify common patterns in the development of economic, demographic and social indicators of the five analyzed countries that have been subject to military conflicts over the period from 2000 to 2020. The development of each country was analyzed in detail and the conclusion was reached that hybrid wars do not have a noticeable effect on the average life expectancy. Moreover, the results of the cluster analysis also demonstrated a strong effect of economic development on life expectancy at birth measured by gross domestic product per capita.

We also applied a one-lag panel vector autoregressive model to study the impact of public economic and social policies on life expectancy at birth in the analyzed countries. For this purpose, we used such indicators, as GDP per capita, current health expenditure per capita, military expenditure, public expenditure on education, armed forces personnel, and social contributions, domestic credit to private sector by banks, inflation and unemployment. To account for periods of hybrid wars and military conflicts we included a dummy variable. The variance decomposition of life expectancy at birth demonstrates that its volatility is largely explained by its own fluctuations at almost 85%. The results of estimation also showed that the most significant impact on life expectancy at birth comes from the positive effect of gross domestic product per capita shock.

Concerning the perspectives of research, it is necessary to study the dependence between the country's income level, its economic development and the level of social security in order to identify ways to overcome the "trap of social insecurity" and ensure the sustained long-run growth.

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