

Article

The Migration Influence on the Forecasting of Health Care Budget Expenditures in the Direction of Sustainability: Case of Ukraine

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Abstract: The start of the full-scale Russian-Ukrainian war caused the largest wave of migration in the 21st century. More than five million Ukrainian citizens left for EU countries within a few months of the start of the conflict. The purpose of this paper is to forecast the level of health care expenditure in Ukraine for 2023–2024, considering the scale of migration and the fall in the level of GDP. The authors propose three scenarios for the development of Ukraine's economy in 2023–2024, taking into account changes in the age structure of the population, migration, and the amount of health care expenditure: (1) Pessimistic, in which economic growth will resume only in 2024, with a GDP rise of 5.6%, provided that the war concludes at the end of 2022. Under this scenario, inflation will be about 21% in 2023–2024, a slight decrease compared with the previous year. Some 12% of the population of Ukraine will have emigrated, resulting in a corresponding 12% drop in health care expenditure in 2023–2024. (2) Basic (realistic), in which economic growth will be about 5% in 2023–2024, inflation will be under 10%, and migration will have accounted for 5% of the country's population. Under this scenario, there will be an increase in health care expenditure of more than 40% in 2023–2024. (3) Optimistic, according to which rapid economic growth is expected in 2023–2024, inflation will not exceed 7%, the majority of those who left Ukraine in the early months of the war will return, and health care expenditure will increase by more than 70% in 2023–2024. The methodology of forecasting public expenditure on health care has been based on a six-step cohort method. The results have indicated that the cost of updating the age structure of Ukraine's population every year will decrease due to the aging of the population, and the overall impact of demographic processes will be negative. The impact of mass migration due to the war creates a significant change in health care costs, requiring administrative bodies to monitor the situation promptly and make appropriate changes to the structure of budget expenditure.

Keywords: migration; budget expenditure; health care system; analysis; GDP; OECD

1. Introduction

The start of a full-scale Russian-Ukrainian war caused the largest wave of migration in the 21st century. As a result of Russia's invasion, over three million refugees, mostly women, children, and the elderly, rapidly crossed into Poland. In total, more than five million Ukrainian citizens left for EU countries within a few months of the outbreak of the war. Since the COVID-19 epidemic had not yet been brought under control at the time of the migration wave, and the level of vaccination in Ukraine was one of the lowest in Europe, this situation posed a significant epidemiological risk.

This research is multifaceted. It includes such diverse concepts as migration, budget expenditure on health care, methods of cohort analysis, and forecasting. The main purpose

of the paper is to propose some alternative scenarios for the development of the Ukrainian economy, given the changes in the population size because of migration and the level of healthcare expenditure, etc.

Cohort analysis from the point of view of practical application is common in multiple industries such as e-commerce, digital marketing, mobile applications, cloud software, games, fintech, medtech, foodtech, etc. In scientific research, cohort analysis is most often used in demography, social research, and medical statistics. However, the use of cohort analysis in economic research is very limited, reflecting the novelty of using this method in financial modeling and forecasting.

The basics of cohort analysis are outlined in many works. In [1], much attention is paid to the application of statistical and mathematical methods in demography. The authors defined the key mathematical concepts that form the basis for historical and modern demographic analysis. One of the methods is cohort analysis. The research in [2] presents cost-effective, powerful methods for creating demographic estimates and forecasts. In addition, both traditional and new applications of the cohort-change ratio method are presented, together with real empirical examples. Work [3] is one of the fundamentals in the application of cohort analysis in social and behavioral sciences. It is argued that many phenomena require specifications that include interactions between two or more parameters—age, period, and cohort.

An encyclopedic overview of forecasting methods is presented in [4]. A large number of forecasting programs require a diverse set of forecasting methods to solve real-world problems. The article presents a non-systematic review of the theory and practice of forecasting. An overview of a wide range of theoretical, state-of-the-art models, methods, principles, and approaches for preparing, creating, organizing, and evaluating forecasts is offered. It also demonstrates how such theoretical concepts are applied in a variety of real-life contexts.

Studies that take into account the impact of migration on economic processes are also important for our research. In [5], the long-term impact of interregional migration on population forecasting in Japan was discussed. The movement of the population from rural areas to urban agglomerations led to the economic devastation of certain area, and to an increase in the burden on the urban infrastructure. As a result, the task of social support of the urban population became more complicated. The current paper modifies cohort analysis in two aspects of the “dependent structure” in the system model. The migration sub-model is extended to include related structures between available employment opportunities and available labor in each region, specified using a spatial autoregressive model. An advantage of modified cohort analysis for rational future planning is the consideration of longitudinal changes in the spatial distribution of the labor force. The test of our proposed model provides an alternative long-term effect of the population distribution of Japan, which is compared with a conditional cohort analysis.

Another study [6] used machine learning to predict health care costs among undocumented, legal, and US-born migrants, based on cohort analysis. Undocumented immigrants were found to be less likely to use health care services and have lower costs than legal immigrants and US-born individuals. Research [7] tests the hypothesis of whether long-term migration was self-selected among survivors of the devastating 1988 Spitak earthquake in Armenia. At the same time, cohort analysis is used as a research method. Migrants and non-migrants are considered as cohorts. In the work, the main focus is migration as a consequence of a natural disaster. Self-selection is typical of economic migration as opposed to post-disaster emigration. The paper concludes that providing adequate housing and employment opportunities to disaster survivors can reduce the likelihood of their emigration and prevent the detrimental effects of human capital loss for small countries with limited human resources.

The intensity of internal migration fluctuates over time, but both migration levels and trends show great diversity. The article [8] proposes ten cohort indicators that can be applied to both prospective and retrospective data in order to systematically study

long-term trends. The proposed cohort indicators provide a more complete picture of migration behavior and should be used to complement period indicators when examining long-term trends.

The world faces ever-increasing problems relating to shortages of skilled workers, migration, and economic downturns. Such trends are exacerbated by unexpected developments such as wars, pandemics and other major crises. Solutions are sought and explored in a variety of industrial and academic settings, including engineering, social sciences, management, political science, and computer science [9–11]. From the point of view of this article, this is an additional topic of Industry 4.0 and, more specifically, environmental sustainability in the working environment. Some tasks cannot be performed under conditions of robotics or automation; therefore, new tools to support human work are expected. The work [12] presents such popular support tools related to augmented reality (AR) and artificial intelligence (AI). The issues considered in this paper have an indirect effect on the formation of the budget, which, in turn, can lead to changes in budget expenditure on health care.

It is also important to mention the works of Polish and Ukrainian scientists, who are devoted to the problems of migration due to the Russian-Ukrainian war [13,14]. Research [15] examines the issue of health care for migrants in Poland, which undoubtedly affects the budgetary costs of health care both in Poland and in Ukraine. A further study by Polish scientists, dedicated to migration as a consequence of the Russian-Ukrainian war, is [16]. A separate issue under consideration is the form of assistance to refugees, their legal support, as well as the impact of migration on budget expenditure.

The study [17] is an attempt to estimate the possible future number of immigrants from Ukraine in Poland and indicates related problems. This creates certain challenges for public services and institutions in Poland. It is shown that labor immigration to Poland, the crisis on the Polish-Belarusian border, and the influx of war refugees from Ukraine changed the status of Poland from a typical country of emigration to one of immigration, without passing through an intermediate phase.

The article [18] examines the relationship between the state of the economy and health by breaking it down into macroeconomic indicators. Data for 21 European countries were used to estimate panel models covering the period from 1995 to 2019. The results found that GDP has a positive effect on life expectancy, and that unemployment has a positive effect on health, although the latter effect is relatively short-lived. The authors conclude that social benefits or budget imbalances can play a protective role during economic downturns.

Study [19] is devoted to the mutual influence of the level of education, health and income. Researchers have attempted to explain the relationship between education and health by considering mediators, such as income, through which education affects health. Research has shown that the relationship between education and health varies by age and cohort. This article brings these themes together in an examination of the role of income in the changing relationship between education and health. The direct relationship between education and health was found to weaken across cohorts, while the indirect effect of education through income strengthened across cohorts. Cohort changes in this indirect effect are equally attributable to changes in the relationships between education and income as well as between income and health.

Since the main issue of this paper is the forecasting of budget expenditures, the following works devoted to the subject are of particular interest. The work [12] examines the mutual influence of the demographic situation in the country and government expenditure on education. Since health care expenditure can be considered to be part of GDP (as can education expenditure), an appropriate analysis method can be applied to predict the impact of migration processes on public expenditure in order to ensure budgetary sustainability. In the work, an analytical assessment is carried out looking at the impact of changes in the level of education expenditure, caused by demographic aging in Ukraine, on budget sustainability. Decomposition of expenditure by age structure of the population was carried out, which can be considered as an application of cohort analysis to some extent.

In [20], it is stated that the expenditure of the consolidated state budget reflects the state of the government's performance of its main functions, and allows the priority areas of state policy implementation to be determined. Analysis of state budget expenditure with the example of Ukraine showed the imbalance of its structure. It was determined that minimal changes in government procurement expenditure were necessary in order to harmonize the structure of the Ukrainian budget expenditure with the approaches implemented in the European Union. In addition, significant areas of funding were health care, economic activity, social protection, and security. For example, health care required a more than four-fold increase in funding. At the same time, interbudgetary transfers needed to be significantly reduced. The amount had to be revised after the completion of financial decentralization reforms.

Articles [21,22] reveal the essence of budget expenditure as a tool for regulating a country's demographic and economic development. A serious challenge is the improvement of forecasting and planning of budget expenditure taking into account demographic factors. An analysis of trends in the demographic development of Ukraine was carried out, and the priority areas of budget regulation of the demographic situation in the country were determined using the regulatory potential of budget expenditure. Budget expenditure forecasting is based on considering the interaction of indicators such as budget expenditure and the demographic structure of the population.

In resources [23–25] the drop in GDP in the countries involved in the Russian-Ukrainian war 2022 (Figure 1) and the protracted recession of the world economy due to the events in Ukraine are discussed.

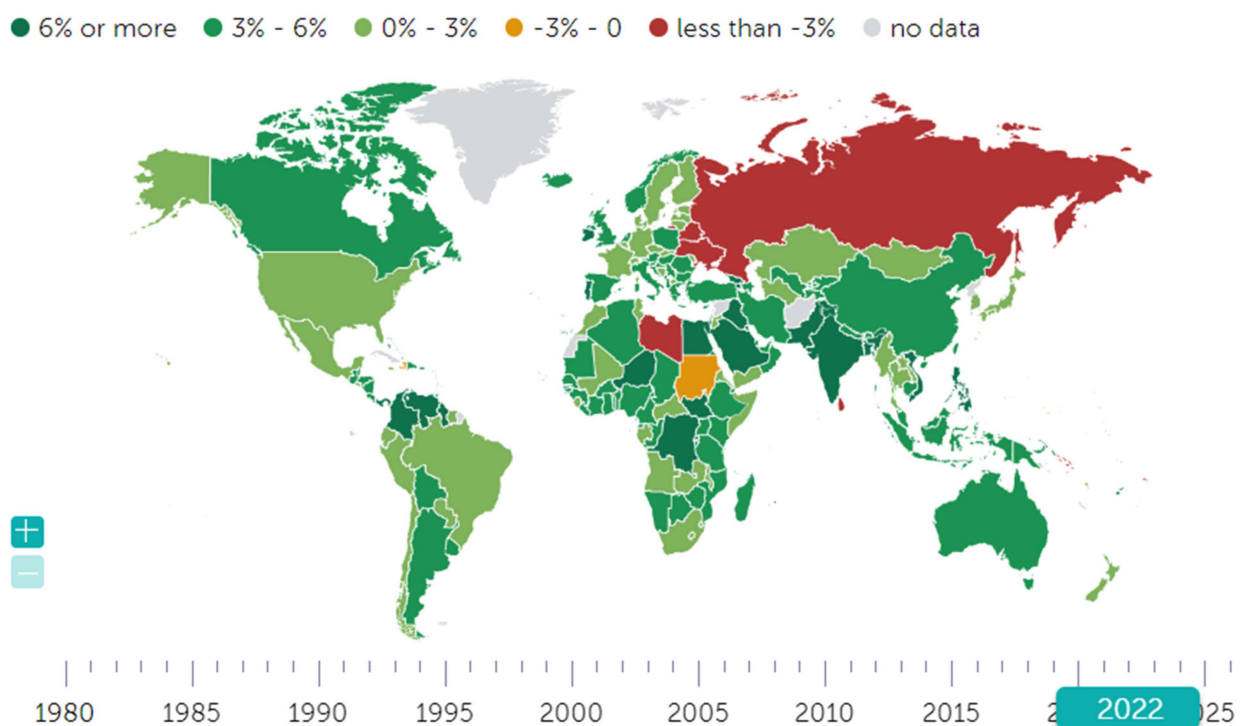


Figure 1. Real GDP growth 2022, annual % change. Source: [23].

Despite the scientific output of the above-mentioned resources, further research is needed to forecast public spending on health care, taking into consideration significant changes since the beginning of the war in Ukraine in 2022.

The research questions are:

- (1) What is the net impact of changes in the age structure, under the influence of population migration, on the total volume of health care expenditure?
- (2) What will be the total impact of demographic trends on the amount of public spending on health care, taking into consideration changes in the age structure of the population

and the projected decrease in the overall size of the permanent population of Ukraine due to migration?

Research suggests that the war will have a negative impact on the demographic structure of the population, as a result of which the structure of health care costs will significantly change.

2. Methodology

When forecasting public expenditure on health care, the basis of the approach considering the age structure of the population is the concept of cohort and the cohort method. Cohort N^t is a group of people in the permanent population, whose age at the beginning of the calendar year t is N full years, where $N = 1-99$. A prerequisite for applying the cohort method for the analysis and forecasting of state expenditure in the medium and long term is the availability of historical and forecast data on the size of the permanent population of the country in terms of cohorts.

The algorithm for applying the cohort method is constructed as follows:

Step 1. For a defined type of state expenditure, a group of recipients is defined, which includes all final recipients of relevant state services or payments. In accordance with Articles 6 and 11 of the “Basics of the Legislation of Ukraine on Health Care”, every citizen of Ukraine has the right to health care, as well as foreign citizens and stateless people who permanently reside on the territory of Ukraine. Therefore, the entire permanent population of Ukraine belongs to the group of recipients of state health care services.

Step 2. The group of recipients defined in the previous step is divided into basic subgroups. This distribution is carried out according to the following principle: a separate base subgroup includes recipients belonging to the same cohort or to adjacent cohorts, for which the volume of expenditure per person can be considered approximately the same. That is, within each basic subgroup, the volume of this type of government expenditure per member is considered unchanged. At the same time, representatives of the same cohort can belong to different basic groups.

Step 3. For each of the previously defined basic groups, the dependence of its number on the number of age cohorts, whose representatives are or are not included in its composition according to the definition, is determined and formalized in the form of a mathematical formula.

Step 4. Based on historical data on the volume of this type of government expenditure and the distribution of relevant services among basic groups of final recipients, the amount of such expenditure per member of each basic group is determined.

Step 5. Using the forecast data regarding the number of age cohorts, the number of each of the base groups in each year of the forecast period is determined. It is possible that the composition of basic groups in the current study will change, not only due to changes in the age structure of the population, but also for other reasons, for example, as a result of migration processes. In the context of the escalation of the war in Ukraine, population migration is growing at a rapid pace, which requires taking this factor into account when forecasting health care expenditure. In this case, the forecast scenario is determined not only by the trajectories of changes in expenditure per member of the base group, but also by a description of the evolution of the base groups themselves and, if necessary, some additional assumptions. The source of data on the age structure of the population was the Government Statistics Service of Ukraine, and the source of data on migration was the United Nations, which maintains regularly updated statistics on migration from Ukraine.

Step 6. In each year of the forecast period, the amount of state expenditure of this type is taken as the sum of the amounts of relevant expenditure for all basic groups of recipients. For each basic group, the amount of expenditure is equal to its forecast number multiplied by the forecast volume of expenditure per one of its members. The forecast volume of expenditure per member of the base group can be taken at the level of the last year of the base period (inertial forecast scenario) or determined based on the forecast data regarding its real growth and inflation rates (alternative scenario). In the latter case, the

amount of expenditure of this type in each year of the forecast period for each base group is determined by multiplying the corresponding amount of expenditure under the inertial forecast scenario by the value of the corresponding chain index in this year.

To apply the cohort method according to the algorithm described above, it is necessary to divide the entire permanent population into basic subgroups. Considering the fact that the need for the services of medical facilities and other health care services is determined by the state of health of a person and the specificity of his or her physiological needs at a certain age, this distribution can be carried out by assigning the full number of adjacent age cohorts to the basic subgroups. At the same time, the choice of the upper and lower age limits for the basic subgroups of the recipient group is determined by the availability of statistical data on the distribution of state expenditure on health care by individual age groups of the population, which is necessary to determine the corresponding expenditure per member of such a group. Note that if the data are available, it is preferable to use the smallest distribution, as this makes it possible to generate more accurate estimates.

Currently, there is no information in terms of age groups on the value of medical and other health care services provided to the population at state expense in Ukraine, which complicates the application of the general approach in its pure form. In this regard, we suggest the following method of distribution of public expenditure on health care by age groups of final recipients of relevant services, which includes a mechanism for determining basic subgroups.

We decided to use the average distribution of public expenditure on health care by age groups of the population in countries that are part of the Organization for Economic Cooperation and Development (OECD), where such information is collected and summarized, as a base. For most OECD countries, the Statistics and Data Directorate regularly publishes relevant data by the following age groups: 0 to 14 years, 15 to 19 years, 20 to 49 years, 50 to 64 years, 65 to 69 years, and 70 up to 74 years, from 75 to 79 years and from 80 years and older. In the terminology we have adopted, these groups are precisely the basic subgroups of the group of recipients of public health care services.

Using the above-mentioned data, the annual volume of state health care expenditure per member of each of the basic subgroups is determined for each country, and an age profile of the distribution of state health care expenditure is constructed. To build this profile, a certain age group is selected for which expenditure per member is assumed to be 1. For the rest of the age groups, the ratio of the amount of expenditure per group member to the amount of expenditure per member of the selected group is determined. The obtained values form a profile that may vary depending on the country and the period under consideration. However, given the significant inertness of the factors on which these ratios depend, the profile for an individual country at least in the medium term can be considered unchanged.

The result of the calculations thus described is a set of profiles of public spending on health care for a number of OECD countries. Based on this set, the age-averaged profile of public health spending for selected OECD countries over a certain period is created.

Before proceeding to the direct determination of the average profile, the entire set of individual profiles should be carefully reviewed for the presence of profiles that are significantly different from the rest (that is, to identify anomalies that may be associated with the specifics of the organization of the health care system or the state policy in relation to certain categories of the population). If such “abnormal” profiles are detected, the countries to which they correspond should be excluded from further consideration. Countries that are not excluded from consideration after the preliminary selection form the final list of selected OECD countries. The average age profile of government spending on health care is determined by finding the arithmetic mean of the profile for each basic subgroup from the final list of selected OECD countries.

Previously, as a basic assumption, we accepted the thesis that the natural human need for medical and other health care services is determined mainly by physiological factors. The average rate of aging plays a decisive role in this. Therefore, in order to correctly

apply the obtained averaged profile to the age structure of the population of Ukraine, it is necessary to adjust it taking into account the difference in the rates of aging in Ukraine and those countries for which the data were used in the construction of the averaged age profile of state expenditure on health care. In this methodology, such an adjustment is made by applying a corrective (compression) coefficient—the ratio of the average life expectancy at birth in Ukraine and the average value of the same indicator in selected OECD countries—to the limits of the basic subgroups of the recipient group.

Initially, the coefficient is determined by:

$$K(t) = \frac{T_{UKR}(t)}{T_{OECD}(t)}, \quad (1)$$

where $T_{UKR}(t)$ —average life expectancy in Ukraine per year t ; $T_{OECD}(t)$ —average life expectancy in OECD countries, defined as the average of the corresponding indicator for selected countries per year t . We expect that this coefficient for Ukraine will be ~90% due to the lower average life expectancy in Ukraine which correlates with the level of the economy and the level of medicine development in OECD countries.

Next, using the found value of K , we “compress” the margins of the age groups that form the basic subgroups of the recipient group in OECD statistics (Table 1).

Table 1. Margins of the basic subgroups of the recipient group.

OECD Countries		Ukraine	
0	14	0	$[K \times 14]$
15	19	$[K \times 14] + 1$	$[K \times 19]$
20	49	$[K \times 19] + 1$	$[K \times 49]$
50	64	$[K \times 49] + 1$	$[K \times 64]$
65	69	$[K \times 64] + 1$	$[K \times 69]$
70	74	$[K \times 69] + 1$	$[K \times 74]$
75	79	$[K \times 74] + 1$	$[K \times 79]$
80		$[K \times 79] + 1$	

Note: The entry $[x]$ means the integer part of the number x . Remarks: The sources of data used in the calculations described above are: for Ukraine—the State Statistics Service of Ukraine; for OECD countries—Statistics and Data Directorate of the OECD. Ideally, all calculations should be made using data for the same period. However, as noted earlier, the indicators used are highly inert, so in cases where such data are not available, the use of data for different but similar time periods is allowed.

The age profile of public spending on health care for Ukraine, taking into account migration processes (the number of people, including women and children, and pensioners, who left Ukraine because of the conflict in 2022), is found as an extrapolation based on open UN data, provided that the value of the profile for of each of the basic subgroups of the recipient group of Ukraine is taken at the level of the average profile value for the selected OECD countries for the corresponding basic subgroup, where the correspondence is established by the above table. Having this profile at our disposal, we can apply the general algorithm of the cohort method described above.

The number of each basic subgroup is a simple sum of the number of age cohorts that form it. Thus, the relationship between the number of each of the 8 basic subgroups of the recipient group and the number of individual age cohorts is described by the following formula:

$$Y_j = \sum_{a_j}^{b_j} x_i, \quad (2)$$

where Y_j is the average annual number of the j -th base subgroup of the recipient group; a_j and b_j are the lower and upper limits of the j -th base subgroup, respectively; and x_i is

the average annual number of the i -th age cohort of the population and is defined as the arithmetic average between the number of this cohort at the beginning and end of the year.

The volume of public expenditure on health care per member of each base subgroup is determined on the basis of data on public expenditure on health care in the base period, taking into account the age profile of expenditure:

$$E = e * \sum_{j=1}^8 (Y_j * c_j), \quad (3)$$

where E is the total amount of government spending on health care for the year under consideration; e is estimated amount equal to the nominal volume of annual health care expenditure per member of the basic subgroup for whose members the relative volume of expenditure is assumed to be 1; Y_j is the average annual number of the j -th base subgroup; and c_j is the value of the age profile of public health care expenditure for the j -th base subgroup.

Thus, for the j -th basic subgroup, the volume of government expenditure per member is equal to:

$$e_j = e * c_j, \text{ where } e = \frac{E}{\sum_{j=1}^8 (Y_j * c_j)}, \quad (4)$$

Therefore, the value e is key for further forecast calculations, as its dynamics in the forecast period completely determine the forecast scenario. In particular, the assumption of the unchangeable nature of the value of e and, as a result, of the value of c_j (with a fixed age profile of expenditure) leads us to the inertial forecast scenario, which allows us to estimate the “net” impact of changes in the age structure of the population on public expenditure on health care.

More realistic scenarios are likely to predict changes in e over the forecast period due to (a) inflation, and (b) real growth/decrease in health care spending per person, which is not related to changes in the age structure of the population. Assumptions about inflation rates are formed based on external forecasts of macroeconomic indicators. Assumptions regarding the real increase/decrease in the value of health care expenditure per person are formed based on the analysis of the values of this factor in the base period, taking into account the tasks of state policy in the field of health care for the medium and long term.

After the forecast scenario is defined, i.e., the dynamics of the value of e in the forecast period, health care expenditure is calculated for each year of the forecast period.

For the practical application of the described methods, the necessary input information is a sufficiently detailed forecast of demographic development indicators, which, in particular, should contain information about the number of age cohorts in the forecast period. In order to correctly formulate a scenario of a forecast, different from an inertial one, it is also necessary to have forecast data (or reasonable assumptions) regarding the main indicators of the socio-economic development of the country, including the rates of economic growth (real GDP growth), indicators of the labor market, incomes of the population, the number of people designated as refugees, etc. In addition, in order to obtain a forecast of budget indicators in nominal terms, it is important to have as input information a forecast of inflation rates for the entire forecast period.

In this study, the input data included the medium-term demographic forecasts of international organizations, UN and International Organization for Migration (IOM) Ukraine data on population migration (number of immigrants from Ukraine and its dynamic), and the results of surveys by the Gradus and Kyivstar companies regarding the potential return to Ukraine after the cessation of hostilities (percentages of Ukrainians who plan to return in Ukraine after the war or plan to stay in their new countries). It was also relevant to use other data sources with surveys of Ukrainians prepared by various research companies, where available. The main source of macroeconomic forecasts in this case was the official forecast for 2022–2024 from the National Bank of Ukraine, forecasts from the World Bank and from the European Bank for Reconstruction and Development. The database of the

State Statistics Service of Ukraine (with dynamic of population by all age groups), as well as the data of consolidated budgets (with dynamic of expenditure on health care), were used as input information regarding the actual indicators for the period until 2021.

3. Results and Discussion

As mentioned above, statistical information that would allow determining the distribution of public health care services among the age groups of their final recipients is not currently collected in Ukraine, and only national statistics are available (Table 2). According to the methodology described in the previous section, at the first stage of forecasting, information about public expenditure on health care per person should be analyzed by age group for the countries where such data are collected, namely, the countries of the Organization for Economic Cooperation and Development (OECD).

Table 2. Actual values of economic indicators, which are the basis of calculations.

Year	GDP In Actual Prices, UAH Million	GDP Growth Rate, %	Real GDP in 2019 Prices, UAH Million	Real GDP Growth Rate, %	Deflator	Chain Deflator in 2019 Prices	Expenditure on Health Care in Actual Prices, UAH Million	Growth in Health Care Expenditure, %	Share of Health Care Expenditure in GDP, %	Real Expenditure on Health Care in 2019 Prices, UAH Million	Growth of Real Health Care Costs, %
2010	1,079,346	18.2%	3,990,584	1950.5%	1.137	0.27	8759	...	0.81%	32,384	...
2011	1,299,991	20.4%	4,209,386	5.5%	1.142	0.31	10,234	17%	0.79%	33,137	2.3%
2012	1,404,669	8.1%	4,212,101	0.1%	1.080	0.33	58,454	471%	4.16%	175,282	429%
2013	1,465,198	4.3%	4,212,115	0.0%	1.043	0.35	61,569	5%	4.20%	176,996	1%
2014	1,586,915	8.3%	3,936,114	−6.6%	1.159	0.40	10,581	−83%	0.67%	26,244	−85%
2015	1,988,544	25.3%	3,551,438	−9.8%	1.389	0.56	11,450	8%	0.58%	20,450	−22%
2016	2,385,367	20.0%	3,638,128	2.4%	1.171	0.66	12,456	9%	0.52%	18,998	−7%
2017	2,981,227	25.0%	3,723,986	2.4%	1.221	0.80	16,729	34%	0.56%	20,897	10%
2018	3,560,302	19.4%	3,853,893	3.5%	1.154	0.92	22,618	35%	0.64%	24,483	17%
2019	3,977,198	11.7%	3,977,198	3.2%	1.082	1.00	38,562	70%	0.97%	38,562	58%
2020	4,222,026	6.2%	3,827,942	−3.8%	1.103	1.10	124,925	224%	2.96%	113,265	194%
2021	5,459,574	29.3%	3,958,092	3.4%	1.251	1.38	170,505	36%	3.12%	123,613	9%

Source: State Statistics Service of Ukraine, World Bank, National Bank of Ukraine, State Budgets of Ukraine, State Treasury Service of Ukraine.

Based on the data of the Statistics and Data Directorate of the OECD on public expenditure on health care, in the fundamental work of Hegist and Kotlikoff [26], age profiles of public expenditure on health care were constructed for ten countries, whereas the unit expenditure for the average person aged 50–64 years old was taken. The analysis of these data showed that one of the profiles from the given population—the USA—was anomalous and could not be considered typical. Therefore, according to the provisions of the methodology, it needed to be excluded from further consideration. Profiles for the remaining nine OECD countries are shown in Table 3, which contains the ratio of average expenditure per person in the relevant age group to average expenditure per person aged 50–64.

Using this data, an averaged age profile of state health care expenditure per person can be derived. It reflects the average person's need for medical services depending on their age; the difference in levels when moving from one age group to another is mainly due to reasons of a physiological nature.

Table 3. Age-normalized profiles of public expenditure on health care for some OECD countries.

Country	0–14	15–19	20–49	50–64	65–69	70–74	75–79	80+
Australia	0.6	0.57	0.64	1.00	1.81	2.16	3.9	4.23
Austria	0.28	0.28	0.46	1.00	1.42	1.75	1.98	2.17
Canada	0.43	0.61	0.65	1.00	2.45	2.44	4.97	7.54
Germany	0.48	0.43	0.58	1.00	1.52	1.8	2.11	2.48
Japan	0.44	0.22	0.43	1.00	1.7	2.2	2.76	3.53
Norway	0.57	0.34	0.52	1.00	1.7	2.21	2.69	3.41
Spain	0.57	0.39	0.48	1.00	1.46	1.73	1.97	2.11
Sweden	0.43	0.43	0.63	1.00	1.5	1.5	1.96	1.99
Great Britain	1.08	0.65	0.76	1.00	2.07	2.07	3.67	4.65
Average value	0.54	0.44	0.57	1.00	1.74	1.98	2.89	3.57

Source: Statistics and Data Directorate of the OECD.

The statistical data used were collected in countries with a high level of socio-economic development, the average life expectancy of which significantly exceeds that of Ukraine (Table 4). Average life expectancy in Ukraine is only about 89% of the average life expectancy in selected OECD countries.

Table 4. Average life expectancy in OECD countries in comparison to Ukraine.

Country	Average Life Expectancy	Country	Average Life Expectancy
Austria	81.30	Latvia	73.40
Belgium	81.90	Lithuania	74.50
Czech Republic	77.40	Luxembourg	82.80
Denmark	81.40	Netherlands	81.50
Estonia	76.90	Norway	83.20
Finland	82.00	Poland	75.60
France	82.50	Portugal	81.20
Germany	80.90	Slovak Republic	74.80
Greece	80.30	Slovenia	80.90
Hungary	74.50	Spain	83.30
Iceland	83.20	Sweden	83.20
Israel	82.80	Switzerland	84.00
Italy	82.90		
Average	79.91	Ukraine	71.35

Source: Statistics and Data Directorate of the OECD, State Statistics Service of Ukraine.

Therefore, according to the methodology described above, we must adjust the averaged age profile taking into account the difference in average life expectancy. To do this, we “squeeze” the boundaries of the basic subgroups that form the profile, taking into consideration the ratio between life expectancy in Ukraine and the average life expectancy in selected OECD countries. The compressive factor K, respectively, is equal to 89%.

Using the found value of K, we find the boundaries of the age groups that form the basic subgroups of influenza recipients in OECD statistics (Table 5).

Table 5. Borders of basic subgroups of the recipient group.

Number (Index) of the Basic Subgroup	OECD Countries		Ukraine	
1	0	14	0	12
2	15	19	13	17
3	20	49	18	44
4	50	64	45	57
5	65	69	58	62
6	70	74	63	66
7	75	79	67	71
8	80	...	72	...

Source: Statistics and Data Directorate of the OECD, State Statistics Service of Ukraine.

In accordance with the determined margins of the basic subgroups of the recipient group and the average profile of public health care expenditure in OECD countries, the age profile of public health care expenditure for Ukraine is determined by the extrapolation method, which is assumed to remain unchanged for the forecast period.

For further calculations, data on the number of base subgroups in two periods (base and forecast) are required. The source of actual data for the years of the base period is the State Statistics Committee of Ukraine. The data of the above-mentioned long-term demographic forecast (the base scenario), developed as part of the joint Ukrainian-Canadian project “Ability to analyze socio-economic results and potential”, are used as forecast data, as well as the expected migration of the population under various scenarios of the end of the war in Ukraine. The indicated data on the number of basic subgroups of recipients are given in Table 6.

Table 7, which contains data on the shares of basic subgroups in the structure of the population of Ukraine, more clearly demonstrates the trends of changes in the age structure of the population. We expect that share of basic subgroups in the population structure will be stable due to proportional migration processes among all groups, as war has significant impact on all of the population.

With the aim of determining the dynamics of the real growth in health care expenditure in the long term, we conducted further calculations of indicators expressed in monetary units at constant 2019 prices. For this purpose, data on the nominal volumes of state expenditure on health care were reduced using the chain deflator index (which is determined on the basis of data on the GDP deflator according to the data of the State Statistics Service of Ukraine) to the volumes of the corresponding expenditure at fixed prices. At the same time, using the data in Table 6 and the age profiles in Table 3, we calculated the value of e , which by definition is equal to the amount of annual health care expenditure per member of the base subgroup, including age cohorts 45–57, and we also calculated this value for other age cohorts, as this is key for further predictive calculations.

The obtained data allowed us to calculate the following indicators for the years of the base period with the help of the formulas described above: the amount of expenses per member of the base group for each of the base subgroups; and the volume of state expenditure in a conditional breakdown into basic subgroups. The specified values could be calculated both in nominal terms and in real terms (in this example, using fixed 2019 prices). The results of these calculations are presented in Tables 8 and 9.

The obtained results make it possible to calculate the total volume of expenditure of the consolidated budget depending on the size and structure of the population of Ukraine, the level of migration, assumptions regarding the real growth in expenditure per person, and inflation rates (in cases where we are interested in values in nominal terms).

In addition, we determined the total amount of government expenditure on health care based on the assumption of unchanged (in real terms) levels of spending per person within the base subgroups (inertia scenario), and considering the real growth in spending

per person within basic subgroups (alternative scenario). In the second case, the rate of real growth in health care expenditure per person of each of the basic subgroups is assumed to be equal to the rate of real GDP growth in the corresponding year of the forecast period.

Table 6. Annual average number of basic subgroups of recipients, thousands.

Number of Basic Subgroups, Thousands of People										
Scenario	Year	Number (Index) of the Base Subgroup								Total Population
	Age Margins	1	2	3	4	5	6	7	8	
	0–12	13–17	18–44	45–57	58–62	63–66	67–71	72+		
	2010	5542	2539	18,295	8728	2792	1335	2419	4132	45,783
	2011	5607	2396	18,211	8649	2901	1462	2097	4275	45,598
	2012	5695	2277	18,088	8609	2930	1611	1848	4396	45,453
	2013	5826	2165	17,997	8500	2916	1893	1606	4471	45,373
	2014	5944	2065	17,855	8419	2906	2011	1523	4522	45,246
	2015	5735	1879	16,802	7857	2769	2003	1481	4234	42,760
	2016	5777	1837	16,576	7793	2802	2056	1631	4120	42,591
	2017	5788	1827	16,333	7708	2884	2004	1834	4036	42,415
	2018	5749	1861	16,064	7627	2925	2020	2048	3925	42,217
	2019	5683	1897	15,815	7496	3009	2015	2148	3920	41,984
	2020	5558	1976	15,547	7406	3033	2049	2237	3926	41,733
	2021	5409	2051	15,268	7356	3028	2101	2255	3952	41,419
	2022	5202	2146	15,003	7327	2978	2126	2233	3983	40,998
Pessimistic	2023	3662	1511	10,562	5158	2096	1496	1572	2804	28,862
	2024	4392	1812	12,666	6186	2514	1795	1885	3363	34,613
Base	2022	3662	1511	10,562	5158	2096	1496	1572	2804	28,862
	2023	4174	1722	12,036	5878	2389	1705	1791	3196	32,891
	2024	4392	1812	12,666	6186	2514	1795	1885	3363	34,613
Optimistic	2022	3662	1511	10,562	5158	2096	1496	1572	2804	28,862
	2023	5084	2097	14,661	7160	2910	2077	2182	3893	40,064
	2024	5058	2087	14588	7124	2896	2067	2171	3873	39,864

Source: State Statistics Service of Ukraine, Gradus, Kyivstar, authors' calculations.

Assumptions about migration for each of the options involve taking into account current dynamic of immigrants and a certain trend for future periods (growth for the pessimistic and basic options, as well as reduction for the optimistic option) and a certain level of change in migration processes in 2022–2024. Thus, in the case of the continuation of hostilities, migration will increase by 5–12%, according to Gradus Research, which will affect the reduction in target subgroups. In the event of the conflict ending, the majority of Ukrainians will return from abroad (72%), according to Gradus. Accordingly, there will be an increase in the number of the population and, accordingly, the size of the target groups. As for the sex-age structure, we assume that it will not change, because some of the women will have gone abroad, and some of the male population will have been killed in the war. The age structure is unchanged due to the forced migration of all age groups of the population.

Thus, we need to consider three alternative scenarios: pessimistic, basic, optimistic (Table 10). The first two scenarios are also valuable in that they make it possible to assess

the “pure” impact of demographic trends, i.e., no increase in expenditure per 1 person of the base subgroup is assumed.

Table 7. Shares of basic subgroups in the population structure.

Year	Number (Index) of the Base Subgroup							
Age Margins	1	2	3	4	5	6	7	8
	0–12	13–17	18–44	45–57	58–62	63–66	67–71	72+
2010	12.1%	5.5%	40.0%	19.1%	6.1%	2.9%	5.3%	9.0%
2011	12.3%	5.3%	39.9%	19.0%	6.4%	3.2%	4.6%	9.4%
2012	12.5%	5.0%	39.8%	18.9%	6.4%	3.5%	4.1%	9.7%
2013	12.8%	4.8%	39.7%	18.7%	6.4%	4.2%	3.5%	9.9%
2014	13.1%	4.6%	39.5%	18.6%	6.4%	4.4%	3.4%	10.0%
2015	13.4%	4.4%	39.3%	18.4%	6.5%	4.7%	3.5%	9.9%
2016	13.6%	4.3%	38.9%	18.3%	6.6%	4.8%	3.8%	9.7%
2017	13.6%	4.3%	38.5%	18.2%	6.8%	4.7%	4.3%	9.5%
2018	13.6%	4.4%	38.1%	18.1%	6.9%	4.8%	4.9%	9.3%
2019	13.5%	4.5%	37.7%	17.9%	7.2%	4.8%	5.1%	9.3%
2020	13.3%	4.7%	37.3%	17.7%	7.3%	4.9%	5.4%	9.4%
2021	13.1%	5.0%	36.9%	17.8%	7.3%	5.1%	5.4%	9.5%
2022–2024	12.7%	5.2%	36.6%	17.9%	7.3%	5.2%	5.4%	9.7%

Source: State Statistics Service of Ukraine, Gradus, Kyivstar, authors’ calculations.

Table 8. Estimated volumes of public expenditure on health care in fixed prices per member of the base subgroup.

Year	Total	Number (Index) of the Base Subgroup							
Age Margins		1	2	3	4	5	6	7	8
		0–12	13–17	18–44	45–57	58–62	63–66	67–71	72+
2010	616	334	268	353	616	1070	1223	1781	2199
2011	632	343	275	362	632	1098	1255	1827	2256
2012	3348	1816	1458	1916	3348	5815	6645	9677	11946
2013	3383	1835	1474	1936	3383	5876	6714	9778	12072
2014	501	272	218	287	501	871	995	1449	1789
2015	413	224	180	236	413	716	819	1192	1472
2016	383	208	167	219	383	666	761	1108	1367
2017	421	228	183	241	421	731	835	1216	1501
2018	492	267	214	282	492	855	976	1422	1756
2019	773	419	337	442	773	1343	1534	2235	2759
2020	2266	1229	987	1297	2266	3935	4497	6549	8085
2021	2474	1342	1078	1416	2474	4297	4910	7150	8827

Source: State Statistics Service of Ukraine, Statistics and Data Directorate of the OECD, State Treasury Service.

Table 9. Conditional breakdown of expenditure of the consolidated budget for health care by basic subgroups of the recipient group, thousand UAH (in constant 2019 prices).

Year	Total	Number (Index) of the Base Subgroup							
		1	2	3	4	5	6	7	8
Age Margins		0–12	13–17	18–44	45–57	58–62	63–66	67–71	72+
2010	32,384	1852	682	6452	5380	2989	1633	4309	9087
2011	33,137	1922	660	6590	5469	3186	1835	3832	9644
2012	175,282	10,339	3321	34,656	28,825	17,041	10,703	17,881	52,516
2013	176,996	10,688	3190	34,844	28,760	17,134	12,711	15,704	53,967
2014	26,244	1616	451	5124	4222	2531	2001	2207	8091
2015	20,450	1283	338	3967	3242	1984	1640	1765	6232
2016	18,998	1201	307	3636	2987	1865	1564	1806	5634
2017	20,897	1320	335	3932	3242	2107	1673	2230	6058
2018	24,483	1534	399	4523	3753	2499	1972	2912	6891
2019	38,562	2382	639	6997	5796	4040	3092	4800	10,815
2020	113,265	6829	1951	20,160	16,783	11,935	9214	14,652	31,742
2021	123,613	7256	2210	21,616	18,200	13,009	10,316	16,124	34,884

Source: State Statistics Service of Ukraine, Statistics and Data Directorate of the OECD, State Treasury Service.

Table 10. Three alternative scenarios considering changes in the population size, its age structure and the amount of health care expenditure used in forecasting.

Assumption	Pessimistic	Realistic	Optimistic
GDP	–35% (NBU)/ –45% drop in 2022 (World Bank). Gradual recovery after protracted war +5.6% in 2024	–33–35% (NBU/IMF) in 2022. Gradual recovery in 2023–2024 +4.9% in 2024	–30% in 2022 (EBRD) Rapid recovery in 2023–2024
Inflation	31.5% in 2022, 20.7% in 2023–2024 (NBU)	31% in 2022, 20.7% in 2023, 9.4% in 2024 (NBU)	20% (World Bank) in 2022, 5–7% in 2023–2024 (EBRD)
Migration	Grows ~12%—potential losses	Grows ~5%—potential losses	Shortened ~72% return
Gender-age structure	Stays the same		
Population size	Decreases in accordance with the demographic forecast and migration processes (6.657 million refugees (UN) + occupied territories = ~20% of the population)		
	In 2023—the risk of losing another 12% of the population (Gradus)	Return of 63% of the population at the earliest opportunity in 2023 (Gradus)	Return of 89% of those who went abroad in case of victory in 2023–2024 (Kyivstar)
The amount of expenses per 1 person of the base group	Stays the same		Grows at rates equal to the rate of real GDP growth

Source: State Statistics Service of Ukraine, IMF, Consensus forecast of the Ministry of Economy and Trade, EBRD, Ministry of Finance of Ukraine, National Bank of Ukraine.

Table 11 contains the results of calculations of the volumes of state expenditure on health care for 2022–2024 according to the defined scenarios.

Table 11. The volume of public expenditure on health care according to the scenarios, UAH million.

Year	Pessimistic			Realistic			Optimistic		
	2022	2023	2024	2022	2023	2024	2022	2023	2024
Expenditure in actual prices	137,994	173,323	254,833	137,994	196,570	233,754	138,547	240,080	288,172
Growth in expenses	−19.1%	−11.9%	47.0%	−19.1%	42.4%	18.9%	−18.7%	73.3%	20.0%
Real expenses	80,163	80,163	96,135	80,163	91,352	96,135	80,163	115,758	121,165
Growth in real spending	−35%	−30%	20%	−35%	14%	5%	−35%	44%	5%

Source: Authors' calculations.

4. Conclusions

Comparing the forecasting results under different scenarios allows us to draw the following conclusions:

1. The net effect of changes in the structure of the population during the entire forecast period will be positive in the sense that, compared to the structure that existed at the end of the base period, the age structure of the population in each subsequent year will require more and more expenditure due to the aging of the population.
2. The total impact of demographic processes (depopulation and population aging, migration) will be negative in the sense that the total volume of expenditure (provided there is no real increase in expenditure per person) will be reduced due to the predominant negative impact of depopulation and migration over the positive impact of aging.
3. The impact of changes in the age structure of the population will increase due to the acceleration of the population aging process.
4. The impact of migration creates a significant change in health care costs, which requires management bodies to monitor the situation promptly and make appropriate changes in budget costs.

All three scenarios are realistic, as they assume the functioning of the government in wartime and its recovery after victory, which is primarily reflected in assumptions about the amount of expenditure per 1 person of the base subgroup. Undoubtedly, the formation of high-quality scenario forecasting, which could become the basis for planning budget expenditure for the medium and long term, requires a more thorough study of the factors affecting real growth in health care expenditure. At the same time, the global experience of long-term forecasting indicators of health care systems shows that the rate of economic growth is the most important factor in the real growth in the quality and volume of medical services, those provided at the expense of the government itself. Therefore, the forecast built according to these scenarios can be considered quite realistic given the conditions of the economic growth rate forecasts adopted by the NBU. Expenditure on health care within the planned scenarios will fluctuate between 3–4% of GDP with a slight upward trend. In the case of a likely deficit in the state's budget, it is relevant to seek additional financial sources that accumulate the level of expenses on health care according to each scenario.

Policies in the field of migration, health care, and public finance must be coordinated, as the return of migrants, the reduction in pressure on public finances due to the age structure of the population, the launch of businesses, and the recovery of Ukraine's economy, depend on their well-coordinated implementation.

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