DOI: 10.55643/fcaptp.2.67.2026.5218

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Received: 16/01/2026
Accepted: 12/04/2026
Published: 30/04/2026

FORMATION AND IMPLEMENTATION OF STATE POLICY TO ENSURE THE FINANCIAL SUSTAINABILITY OF THE HEALTH CARE SYSTEM IN INDETERMINATE CONDITIONS

ABSTRACT

The article explores the theoretical, methodological, and applied principles of formation and implementation of state policy to ensure the financial sustainability of the health care system in indeterminate conditions. The relevance of the topic is determined by the fact that the health care system functions under the influence of a consistent layering of pandemic, military, macroeconomic, and technological shocks, which requires rethinking approaches to state financing, budget response, and managerial adaptability. The purpose of the study is to develop a theoretical and methodological basis and applied tools for assessing the financial sustainability of the health care system and developing proposals for improving state policy in this area. As a result, an integral index of the financial sustainability of the healthcare system was constructed, the impact of macroeconomic and crisis factors on its dynamics was assessed, and basic, stressed, and adaptive scenarios for our country for 2026–2030 were formed. It was proven that the sustainability of the healthcare system is determined not only by the scale of public spending, but also by the structure of funding sources, the level of direct financial burden on the population, the stability of the healthcare budget priority, and the ability of the state to implement technologies based on artificial intelligence in the management of financial flows. The practical value of the work lies in the possibility of using its results by state authorities to improve budget policy, develop a program of medical guarantees, and form adaptive mechanisms to ensure the financial sustainability of the healthcare system.

Keywords: public policy, financial sustainability, healthcare system, indeterminate conditions, public financing, health guarantee program, scenario modeling

JEL Classification: I18, H51, C23, C53, O38

INTRODUCTION

The formation and implementation of the state policy of ensuring the financial sustainability of the healthcare system appears as one of the most significant scientific and practical problems of the current stage of development of our country, since it is the financial sustainability of this system that determines its ability to continuously provide the population with necessary medical services, maintain human resources, maintain the appropriate level of material and technical support, and adapt to prolonged crisis impacts. This issue has gained particular importance after the COVID-19 pandemic, which revealed the critical dependence of the healthcare sector on the volume and stability of state funding, the ability to quickly redistribute resources, form reserves, and ensure the purchase of medicines, equipment, and personal protective equipment. At the same time, for Ukraine, the consequences of the pandemic did not end the crisis, but only preceded an even more destructive stage associated with a full-scale invasion, which sharply increased budget imbalances, increased the need for spending on emergency care, treatment of the wounded, rehabilitation, mental health, restoration of destroyed medical infrastructure and provision of medical care to internally displaced persons. Under such conditions, the healthcare system operates under the simultaneous pressure of demographic losses, migration processes, inflationary growth in costs, staff shortages, and limited state financial resources, which significantly complicates both

current management and long-term strategic planning. Thus, the issue of financial sustainability is no longer limited to the availability of funds, but encompasses the ability of state policy to form sustainable financing mechanisms, maintain flexibility in management decisions, reduce the vulnerability of the system to external shocks, and, at the same time, guarantee the accessibility and quality of medical care.

The study is of additional relevance because the modern healthcare system is entering a new stage of transformation, associated with the mass introduction of artificial intelligence-based technologies that radically change approaches to diagnostics, administration, forecasting needs for medical services, risk assessment, resource allocation, and cost-effectiveness control. On the one hand, such technologies provide new opportunities for improving the effectiveness of financial flow management, reducing unproductive costs, increasing transparency, personalizing patient medical routes, and better using data for decision-making. On the other hand, their large-scale implementation requires significant initial investments, modernization of digital infrastructure, staff training, updating regulatory and legal support, data protection, and the formation of new approaches to state regulation. That is why the state policy of ensuring the financial sustainability of the healthcare system must take into account not only traditional financial and budgetary challenges, but also a new technological reality, in which sustainability is determined by the ability to combine continuity of funding, crisis adaptability, innovative development, and social justice.

LITERATURE REVIEW

In the contemporary literature, the financial sustainability of healthcare systems is usually analyzed through several interrelated dimensions, namely, the architecture of health financing, the quality of public financial management, the design of purchasing mechanisms, and the ability of systems to remain functional under crisis conditions. Global studies remain useful for conceptual framing because they demonstrate that sustainable health financing depends not only on the volume of resources but also on the way funds are pooled, allocated, and monitored. In particular, Barroy et al. (2024) argue that public financial management should be viewed as a strategic pathway toward universal health coverage rather than as a purely technical budgetary function.

De Foo et al. (2023) additionally show that, during crisis periods, resilient financing is associated with the ability to absorb shocks, restore service continuity, and maintain fiscal space for health. However, for the purposes of this article, the literature that is analytically closest is the literature focused on Central and Eastern Europe, because the empirical sample used in the study consists of countries with a shared post-socialist transformation trajectory. In this regard, Tambor et al. (2021) provide an important comparative basis by demonstrating that the healthcare systems of the EU-8 countries continue to face the legacy of reduced public financing and high household out-of-pocket payments, which create persistent equity and financial protection challenges. This is especially relevant for our article, because it directly connects the structure of financing with the sustainability of healthcare systems in the same regional space from which our comparative sample is drawn.

Similarly, Ndayishimiye et al. (2024), analyzing provider-payment reforms across nine Central and Eastern European countries, show that the success of financing reforms depends not only on the formal design of payment systems but also on performance indicators, tariff valuation, information systems, implementation capacity, and stakeholder coordination. Thus, in the CEE context, financial sustainability is inseparable from institutional capacity and reform implementation quality.

A separate line of literature is directly relevant to Ukraine and its comparison with neighboring countries. Panfilova et al. (2021), comparing Ukraine, Poland, and the WHO European region, show that the Ukrainian trajectory has been marked by unstable public financing dynamics and a persistently high burden of household out-of-pocket payments, whereas Poland demonstrated a more stable increase in public participation and a lower relative burden on households. This finding is particularly important for our study because it confirms that the Ukrainian case cannot be adequately interpreted without reference to the broader regional comparison.

In a similar vein, Kwilinski and Vysochyna (2024) argue that the effectiveness of healthcare financing in European countries depends not only on expenditure levels but also on the composition of financing sources, time lags, and the balance between public, private, external, and household expenditures. Their conclusions are directly aligned with the logic of our integral index, which also treats the structure of financing as a central determinant of sustainability rather than a secondary feature.

Recent Ukrainian scholarship also contributes to the understanding of how healthcare financing should be interpreted under conditions of systemic shock. Volkova et al. (2024) show that modern approaches to financing healthcare facilities

in Ukraine require a mixed and institutionally adapted model that combines public guarantees, rationalized budget support, and better coordination of financial flows. Hlushchenko (2025) likewise emphasizes that Ukraine's healthcare financing system must be understood through the interaction of classification systems, financial instruments, wartime adaptation, and transparency requirements.

At the same time, Habicht et al. (2024) demonstrate that Ukraine's wartime resilience was strengthened precisely because earlier financing reforms had already introduced a benefits package, centralized pooling, stronger purchasing, and an e-health infrastructure. This is highly relevant to our article because it suggests that financial sustainability in Ukraine should be interpreted not only as budget sufficiency, but also as the institutional ability to preserve continuity of care under war-related disruption.

Thus, the literature already provides several important insights. First, financial sustainability depends on the quality of pooling, purchasing, and public financial management. Second, in Central and Eastern Europe, the persistence of out-of-pocket spending and the uneven implementation of reforms remain structural challenges. Third, in Ukraine, wartime resilience has been strongly influenced by the pre-war architecture of financing reforms and by the state's capacity to centralize and reprioritize financial flows. At the same time, an important gap remains. Existing studies usually examine either financing reform, household financial burden, or provider-payment design, or wartime resilience separately. There is still insufficient research that combines these dimensions into a single analytical framework capable of comparing Ukraine with Central and Eastern European countries, constructing an integral index of financial sustainability, identifying the role of macroeconomic and crisis shocks, and extending the analysis into forward-looking scenarios under conditions of military pressure and technological transformation. It is precisely this gap that the present article addresses.

AIMS AND OBJECTIVES

The purpose of the study is to form a theoretical and methodological basis and develop an applied toolkit for assessing and substantiating state policy to ensure the financial sustainability of the healthcare system in indeterminate conditions, taking into account the sequential layering of pandemic, military, macroeconomic and technological challenges, as well as to develop practical recommendations for increasing the adaptability of financing, reducing the financial vulnerability of the population and enhancing the effectiveness of state management decisions. To achieve the goal, the following tasks were solved in the article:

1. To generalize scientific approaches to the interpretation of the financial sustainability of the healthcare system in conditions of crisis and structural shocks.
2. To form a system of indicators for assessing the financial sustainability of the healthcare system and to build an integral index based on them.
3. To form an intercountry panel of comparable data for the countries of Central and Eastern Europe, and on its basis to conduct descriptive, correlation, and econometric analysis.
4. To assess the impact of macroeconomic, crisis, and financial factors on the dynamics of the integral index of financial sustainability.
5. To carry out scenario modeling of possible trajectories of the financial sustainability of the healthcare system of our country for 2026–2030.
6. To substantiate practical recommendations for improving the state policy of ensuring the financial sustainability of the healthcare system.

METHODS

The research methodology is based on a combination of general scientific, special economic, and economic-mathematical approaches, which made it possible to reveal the state policy of ensuring the financial sustainability of the health care system as a multi-level process, which combines budget decisions, institutional environment, macroeconomic shocks, and technological adaptation. At the preparatory stage, methods of theoretical generalization, systematization, analysis, and synthesis were applied to clarify the content of the categories "financial sustainability of the health care system", "indeterminate conditions", "adaptive state policy", as well as to form a system of assessment indicators. Comparative analysis was used to compare approaches to health care financing in our country and in the group of Central and Eastern European countries, which made it possible to identify differences in the structure of state participation, the share of direct household

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expenditures, the budgetary priority of health care, and the level of protection of the population from financial risks. The empirical basis of the study was formed on the basis of official international and national sources. For cross-country assessment, comparative series of the World Bank and the World Health Organization were used on the share of current health care expenditures in gross domestic product, the share of domestic government expenditures in current health care expenditures, the share of domestic government expenditures on health care in total government expenditures, as well as the share of direct household expenditures in financing the health care system. For the Ukrainian scenario component, official budget parameters of the Ministry of Finance of Ukraine on total health care expenditures and financing of the medical guarantee program were used. This construction of the information base corresponds to the trajectory presented in the samples, where the stage of sample formation, description of variables, data sources, and the logic of the transition from the descriptive block to modeling are separately highlighted.

The key analytical tool was the integral index of financial sustainability of the health care system, formed on the basis of normalization of input indicators and their further aggregation. This approach made it possible to move from a fragmentary assessment of individual budget characteristics to a generalized indicator that simultaneously reflects the resource availability of the system, the level of state participation, the budgetary priority of health care, and the strength of the financial burden on the population. Correlation analysis and panel econometric modeling were used to identify causal and associative relationships between state, macroeconomic, and crisis factors and the integral indicator of financial stability. At the first stage, a preliminary assessment of the strength and direction of the relationships between the integral index and such variables as real growth in gross domestic product, inflation, public debt, environmental indeterminacy index, and shock variables was carried out. A set of diagnostic procedures was used to verify the correctness of the model and reduce the risk of false conclusions. In particular, the presence of multicollinearity between explanatory variables was assessed through the variance inflation factor, heteroscedasticity, the appropriateness of taking into account individual effects, as well as the risks of specification error were checked.

The calculation of the integral index of financial sustainability of the healthcare system was carried out in 2 stages. At the first stage, all input indicators were reduced to a comparable dimensionless scale from 0 to 1 by minimax normalization. For the stimulating indicators, the growth of which enhances financial sustainability, the following formula was applied:

$$z_{j,it}=x_{j,it}-\min(x_j)/\ \max(x_j)-\min(x_j),$$

where $x_{j,it}$ is the actual value of the jth indicator for the ith country in the tth year, $\min_{f(t)}(x_j)$ and $\max_{f(t)}(x_j)$ are the minimum and maximum values of this indicator within the entire observation panel, respectively, $z_{j,it}$ is the normalized value of the indicator.

For a disincentive indicator, the growth of which weakens financial stability, the following formula is used:

$$z_{j,it}=\max(x_j)-x_{j,it}\ /\max(x_j)-\min(x_j).$$

The stimulating indicators include: the share of current healthcare expenditures in gross domestic product; the share of domestic government expenditures in current healthcare expenditures; the share of domestic government expenditures in total government expenditures.

At the second stage, the generalized financial sustainability indicator, which in this article is identified with the integral index of financial sustainability of the healthcare system, was calculated as the arithmetic mean of the normalized components:

$$HFSI_{it}=\sum^{4}_{j=1}=w_jz_{j,}$$

where $HFSI_{it}$ is the integrated index of financial sustainability of the healthcare system for the i-th country in the t-th year, w_j is the weight coefficient of the j-th indicator, z_j is its normalized value.

The basic specification uses equal weights, i.e., $w_j=0.25$, which made it possible to avoid subjective overestimation of individual components and maintain transparency of the reproduction of results. The closer the value of $HFSI_{it}$ is to 1, the higher the financial sustainability of the healthcare system.

A separate component of the methodology was formed by scenario modeling for our country for 2026–2030. It was necessary because historical cross-country series well reflect the consequences of the COVID-19 pandemic and macroeconomic shifts, but do not fully allow us to assess the future configuration of the military load and the effect of the spread

of technologies based on artificial intelligence. Within this component, three scenarios were built, namely, basic, tense, and adaptive. The basic scenario assumes a gradual increase in state funding and a moderate decrease in the share of direct expenditures of the population. The tense scenario takes into account the preservation of high military pressure, slower budget dynamics, and greater vulnerability of the population. In the adaptive scenario, an additional parameter of technological adaptability has been introduced, which reflects the effect of implementing artificial intelligence-based technologies in medical needs analytics, patient routing, service verification, queue management, procurement, and control over financial flows.

Scenario modeling was carried out using an economic and mathematical approach, within which the forecast trajectory of each key variable was formed recursively. For budget indicators, the formula was used:

$$Bt^{(s)}=B_{t-1}^{(s)}(1+gB^{(s)}),$$

$$Mt^{(s)}=M_{t-1}^{(s)}(1+gM^{(s)}),$$

where $Bt^{(s)}$ is the amount of budget expenditures on health care in year t under scenario s, $Mt^{(s)}$ is the amount of financing for the medical guarantee program, $gB^{(s)}$ and $gM^{(s)}$ are the scenario growth rates of the corresponding indicators.

RESULTS

We present the initial data for Ukraine in a separate table (Table 1). At the same time, the share of healthcare spending in the gross domestic product for our country did not look critically low. On the other hand, almost half of current spending fell directly on households. That is why the integral index turned out to be low. At the same time, budget indicators show a different trajectory, namely a sharp strengthening of the role of the state in the financial provision of the healthcare system.

Table 1. Initial data for Ukraine for the assessment. *(Source: State Statistical Service. Eurostat)*

Indicator	Value
Current health care expenditures, % of gross domestic product	8.20
Domestic government expenditures in current health care expenditures, %	52.12
Domestic government expenditures in total government expenditures, %	10.56
Direct household expenditures in current health care expenditures, %	45.29
Integral financial sustainability index	0.3396
State budget expenditures on health care with transfers, UAH billion	204.2
Total health care expenditures, UAH billion	238.7
Medical guarantee program, UAH billion	157.3
State budget expenditures on health care with transfers, UAH billion	222.1
Medical guarantee program, UAH billion	172.8
State budget expenditures on health care with transfers, UAH billion	258.6
Medical guarantee program, UAH billion	191.6

The sample included our country, Poland, the Czech Republic, Slovakia, Hungary, Romania, Bulgaria, Croatia, Slovenia, Lithuania, Latvia, and Estonia. By sample, we mean not a list of countries per se, but a balanced cross-country panel formed on a country-year basis. That is, each observation unit reflects the value of the indicator system for a specific country in a specific year. This data format was necessary for constructing an integral index, conducting descriptive analysis, calculating a correlation matrix, and evaluating panel econometric models. This set of countries is methodologically justified, since they were formed in a close historical and institutional environment, went through a trajectory of post-socialist transformation, have comparable experience of budget reforms, reorientation of healthcare systems, changes in the role of the state in financing the social sphere, and gradual approximation to European standards of public administration. Under such conditions, the comparison becomes more correct than in the case of including countries with a fundamentally different welfare model, different fiscal capacity, and different health insurance architecture. The choice of Central and Eastern European countries makes it possible to compare health care systems that, on the one hand, are already integrated into the European public policy space or are oriented towards it, and on the other hand, still retain problems

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common to transformation economies, namely limited budget resources, uneven reforms, high sensitivity to inflation and debt risks, as well as increased vulnerability to external shocks. The average values, minimum, maximum, and variability of the integral index and all explanatory variables should be shown (Table 2).

Table 2. Cross-country data matrix for assessment.

Indicator	Number of observations	Mean	Median	Standard deviation	Minimum	Maximum
Integral index of financial sustainability	108	0.526	0.517	0.180	0.134	0.950
Current expenditure on health care, % of gross domestic product	108	7.034	6.927	0.952	4.943	9.527
Domestic government expenditure in current expenditure on health care, %	108	70.316	71.592	10.670	44.790	87.980
Domestic government expenditure on health care in total government expenditure, %	108	11.751	11.965	2.059	6.945	17.588
Direct household expenditure in current expenditure on health care, %	108	25.446	23.180	11.515	8.832	51.119
Real growth in gross domestic product, %	108	2.555	3.097	3.553	-10.079	12.632
Consumer price inflation, %	108	2.524	1.736	5.303	-1.545	48.700
Environmental uncertainty index	108	0.141	0.091	0.138	0.005	0.771

These statistics are used as an analytical prerequisite for further modeling. The calculation of the mean, minimum, maximum, and standard deviation allows us to estimate the central tendency, the limits of variation, and the degree of heterogeneity of indicators within the panel. This is important for 3 tasks. First, to check how comparable the sample countries are. Second, to identify indicators with excessive dispersion that may affect the results of normalization and regression estimation. Third, to meaningfully interpret the scenario results of our country relative to the average parameters of the panel. Table 2 presents the characteristics of 108 country-year observations generated for 12 Central and Eastern European countries. Thus, the indicator 108 is the product of the number of countries and the number of annual periods for which comparable statistical data were collected. This presentation format allows for both cross-country differences and time dynamics of the indicators. At the same time, it is necessary to present a so-called heat map of the financial stability index itself, which will show the spatio-temporal distribution of stability across the entire sample. Its strength is that it allows us to simultaneously see both cross-country differences and temporal shifts (Figure 1).

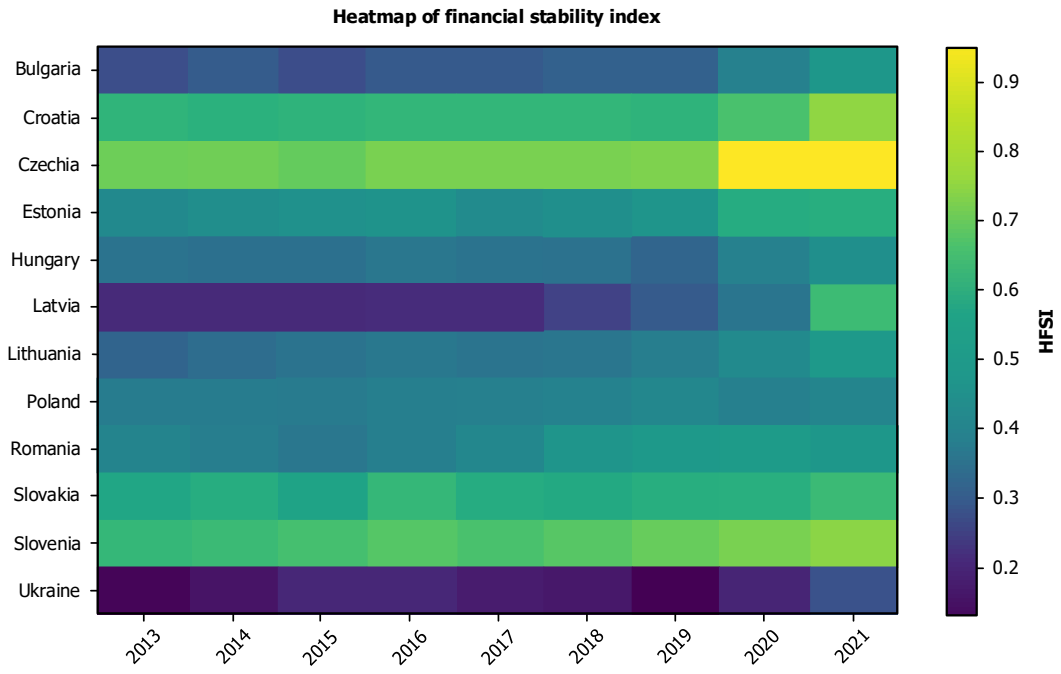

Figure 1. Heat map of financial sustainability by country and year.

The heat map analysis shows that the financial sustainability of health systems within the sample has a clear cross-country and temporal differentiation. Lighter zones correspond to countries and years that combined a higher share of state participation in financing, a higher budgetary priority for health care, and a lower direct financial burden on households. Darker zones, on the contrary, reflect situations when a significant share of costs was shifted to the population, and the budgetary space to support the health care system was more limited. At the same time, the temporal transitions of colors demonstrate that crisis periods did not always automatically worsen the index, since in some countries, anti-shock budget mobilization temporarily strengthened the financial configuration of the system.

The analysis itself is based on the assumption that the integral index of financial sustainability of the healthcare system is a function of macroeconomic dynamics, inflationary pressure, the level of uncertainty, and crisis shocks:

$HFSI_{it}=f(GDPG_{it},INFit,EUI_{it},SHOCK_{it})$.

For empirical testing, this dependence was presented in linear form:

$HFSI_{it}=\alpha+\beta1GDPG_{it}+\beta2INF_{it}+\beta3EUI_{it}+\beta4SHOCK_{it}+\varepsilon_{it.}$

That is why, at the first stage, it is advisable to assess the pairwise correlations between the indicated variables, and only after that proceed to panel modeling, in which individual and time effects are controlled.

It is necessary to show how the integral index, the growth rate of gross domestic product, inflation, the indeterminacy index, and shock variables are related to each other. At the same time, here we will present the summarized results of the VIF, Breusch-Pagan, Hausman, Mundlak, and Ramsey tests. It is established that the most obvious negative relationship is observed between financial stability and inflation (= -0.296). The growth of gross domestic product has a weak positive relationship, and the pandemic shock, on the contrary, in a simple pairwise correlation demonstrates a positive coefficient (Table 3).

Table 3. Correlation matrix and test results.

Indicator	Financial Stability Index	Gross Domestic Product Growth	Inflation	Indeterminacy Index	Pandemic Shock
Financial Stability Index	1	0.141	-0.296	-0.143	0.254
Gross Domestic Product Growth	0.141	1	-0.281	-0.227	-0.135
Inflation	-0.296	-0.281	1	0.667	0.048
Indeterminacy Index	-0.143	-0.227	0.667	1	0.437
Pandemic Shock	0.254	-0.135	0.048	0.437	1
Tests					
Max variance inflation factor			2.56		
Breusch–Pagan, p-value			0.399		
Ramsey RESET, p-value			0.019		
F-test for poolability, p-value			0.000		

Next, we present the key results of the simulation. It should be noted that the term simulation is used as a component of scenario simulation, i.e., the reproduction of the future trajectory of the integral financial sustainability index under various combinations of budgetary, crisis, and technological parameters. Its purpose is not to mechanically forecast a single indicator, but to compare alternative state policy options for our country for 2026–2030. In the model with country fixed effects, the growth of gross domestic product is associated with an increase in the financial sustainability index, and the pandemic shock has a statistically significant positive effect on the financial configuration of the healthcare system. At the same time, the positive sign of inflation in this specification should not be interpreted literally as the "usefulness" of inflation. Rather, it reflects the fact that in the crisis years, inflationary pressure coincided with forced budget expansion and increased state participation in healthcare financing. When we additionally control for years, that is, we cut off the common time shock, the indeterminacy index comes to the fore (Table 4).

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Table 4. Results of panel model evaluation.

Variable	Fixed effects	Random effects	Pooled ordinary least squares	Fixed effects	Fixed effects, Driscoll–Kraay
Gross Domestic Product Growth	0.0038*** (0.0010)	0.0038** (0.0016)	0.0051 (0.0048)	-0.0017 (0.0019)	-0.0017 (0.0012)
Inflation	0.0024*** (0.0007)	0.0023** (0.0011)	-0.0064 (0.0056)	0.0000 (0.0012)	0.0000 (0.0005)
Indeterminacy Index	0.0182 (0.0301)	0.0144 (0.0435)	-0.1834 (0.1855)	0.0891** (0.0437)	0.0891*** (0.0272)
Pandemic Shock	0.1094*** (0.0236)	0.1101*** (0.0163)	0.1454*** (0.0439)	—	—
R^2	0.577	0.568	0.094	0.105	0.105
Number of Observations	108	108	108	108	108

Scenario modeling in our study is used as a continuation of the analysis presented above, but not for comparing countries in the past, but for assessing possible trajectories of the financial sustainability of our country's healthcare system in the coming years. Thus, first, based on official international data, we constructed an integral index of financial sustainability, then, using a cross-country panel, we saw which factors were most associated with strengthening or weakening this sustainability, and only after that, we transferred the identified logic to the Ukrainian context. It is important to note that the integrated index of financial sustainability of the healthcare system was not modified in our article and, therefore, was formed by us on the basis of adapting the general methodology for constructing composite indicators to the tasks of assessing the financial sustainability of the healthcare system. The novelty of the proposed approach lies in the combination of 4 interrelated components, namely resource availability, the role of the state in financing, the budgetary priority of healthcare, and the level of direct financial burden on the population. It is based on real budget guidelines, on the already established role of state funding, direct household spending, military pressure, and institutional adaptability, and then shows how the integral index can change under different combinations of these factors. Thus, the scenario approach makes it possible not only to describe the future but also to assess the extent to which state policy is able to change the trajectory of the financial sustainability of the healthcare system (Tables 5a, 5b).

Table 5a. Scenario modeling results for our country.

Year	Baseline scenario						Stressed scenario					
	HFSI	Health budget, UAH billion	Medical Guarantees Programme, UAH billion	Out-of-pocket share, %	War pressure index	Technological adaptability index	HFSI	Health budget, UAH billion	Medical Guarantees Programme, UAH billion	Out-of-pocket share, %	War pressure index	Technological adaptability index
2026	0.386	258.6	191.6	43.5	0.70	0.35	0.354	250.8	183.9	46.5	0.78	0.25
2027	0.417	279.3	206.0	43.0	0.64	0.45	0.365	260.9	192.2	47.5	0.76	0.28
2028	0.445	298.8	220.4	42.5	0.58	0.52	0.375	270.0	199.9	48.5	0.74	0.30
2029	0.471	318.3	234.7	41.8	0.52	0.58	0.385	278.1	206.9	49.0	0.72	0.33
2030	0.498	337.4	248.8	41.0	0.46	0.65	0.394	286.4	214.1	49.5	0.70	0.35

Table 5b. Scenario modeling results for our country.

Year	Adaptive scenario					
	HFSI	Health budget, UAH billion	Medical Guarantees Programme, UAH billion	Out-of-pocket share, %	War pressure index	Technological adaptability index
2026	0.404	263.8	197.3	42.0	0.66	0.42
2027	0.452	290.1	217.1	40.5	0.56	0.58
2028	0.493	317.7	237.7	39.0	0.48	0.70
2029	0.532	346.3	259.1	37.5	0.40	0.80
2030	0.568	375.7	281.1	36.0	0.34	0.90

The values presented in Table 5 were obtained by sequential scenario recalculation from the latest available baseline indicators for our country. For each subsequent year, the volume of healthcare expenditures and financing of the medical guarantee program was determined based on the value of the previous year, taking into account the higher growth rates embedded in the adaptive scenario. The share of direct household expenditures was calculated as the expected share of household funds in the total financing of the healthcare system, and the adaptive scenario assumed its gradual decrease due to the strengthening of the role of the state and better organization of financial flows. The military pressure index and the technological adaptability index were set not in monetary units, but on a normalized scale from 0 to 1, where a higher value of military pressure means a stronger destabilizing impact, and a higher value of technological adaptability reflects the better ability of the system to use artificial intelligence-based technologies in financial management, patient routing, needs analytics, and resource control. After setting these annual parameters, the integral financial sustainability index was recalculated each time using the same logic as in the main part of the study, i.e., by combining budget dynamics, financing structure, burden on households, the strength of military pressure, and the level of technological adaptability into a single comparable indicator.

The choice of exactly 3 scenarios is due to the need to cover the most realistic range of possible development directions without overloading the model with an excessive number of options. The baseline scenario reflects the most likely trajectory under the conditions of maintaining the current direction of budgetary policy and gradual changes without sharp breaks. The tense scenario is needed to assess the risks if military pressure, financial instability, and burden on households remain high or increase. The adaptive scenario is introduced in order to show not only the risks, but also the potential of active state policy, when increased funding is combined with institutional improvement, reduction of direct costs of the population, and the introduction of technologies based on artificial intelligence in financial flow management, patient routing, needs analytics and control of resource use. Despite the fact that other countries were used in the cross-country part of the study, the scenarios were built specifically for Ukraine, since the tasks of the international panel and the tasks of scenario modeling are different. Other countries were needed to establish a comparative basis, identify general patterns, and show which financial configurations are generally associated with higher health system resilience.

The scenario modeling showed that the financial sustainability of our country's healthcare system is determined not by one single factor, but by a combination of budgetary capacity, the structure of funding sources, the level of direct burden on households, the strength of military pressure, and the ability of state policy to adapt. The baseline scenario reflects the possibility of gradual improvement provided that current approaches are maintained, the stressed scenario shows the risk of preserving financial vulnerability, and the adaptive scenario demonstrates that the best results are achieved when the growth of state funding is accompanied by institutional improvement and technological modernization. Thus, for Ukraine, the key task is not only to ensure a larger volume of funds but also to form a state policy that is capable of transforming financial resources into systemic sustainability (Figure 2).

Thus, the average value of the integral index of financial stability in the sample is 0.526, while under the baseline scenario, our country in 2030 reaches only 0.498, that is, it almost reaches, but still does not exceed, the average level of the panel. Under the stressed scenario, the index value in 2030 is 0.394, which means that a significant lag behind the average intercountry parameters remains. Only under the adaptive scenario does the index increase to 0.568, that is, it exceeds the average value of the sample. At the same time, the average share of direct household expenditures in the panel is 25.446%, while even in 2030, the adaptive scenario for our country assumes 36.0%, and the baseline 41.0%. Thus, the main advantage of the adaptive scenario is not only the growth of the integral index, but also the relative approximation to the financial configuration of more stable countries in the sample. At the same time, a weakness of even the adaptive scenario remains the still rather high private burden on the population, which indicates the need for further strengthening state participation in financing the healthcare system.

Therefore, the strategic direction of improvement should be the transition from reactive management to a proactive model, in which budget planning, a health guarantee program, protection of the population from excessive private spending, infrastructure restoration, and the introduction of technologies based on artificial intelligence form a single coordinated system. It is such a trajectory that makes it possible not only to maintain the functioning of the health care system in a crisis environment, but also to consistently increase its effectiveness, social justice, and readiness for new shocks.

DOI: 10.55643/fcaptp.2.67.2026.5218

Figure 2. Opportunities for increasing the effectiveness of public policy to ensure the financial sustainability of the healthcare system under indeterminate conditions under each scenario.

DISCUSSION

The results of this study support the view that the financial sustainability of the healthcare system is determined not by expenditure volume alone, but by the configuration of financing sources, the degree of public participation, and the level of protection against excessive household spending. In this sense, our findings are highly consistent with Tambor et al. (2021), who demonstrated that in Central and Eastern European countries, the retreat from publicly financed healthcare generated persistent equity and financial protection problems. They also resonate with Panfilova et al. (2021), whose comparison of Ukraine and Poland showed that the Ukrainian trajectory has been marked by more unstable public financing dynamics and a greater household financial burden. Therefore, our conclusion that systems with a higher public financing share and a lower out-of-pocket burden tend to be more financially sustainable should be understood as a regionally grounded finding rather than merely a general budgetary observation.

Our results also reinforce the argument that institutional design matters as much as fiscal capacity. The positive role of crisis-related fiscal mobilization in our models should not be interpreted as evidence that shocks are beneficial in themselves. Rather, it indicates that under acute crisis conditions, states may temporarily strengthen the financial configuration of healthcare through emergency reprioritization, centralized pooling, and accelerated resource allocation. This interpretation is closely aligned with Habicht et al. (2024), who showed that Ukraine's wartime resilience was facilitated by pre-existing financing reforms built around universal entitlement, centralized pooling, stronger purchasing, and digital information infrastructure. It also corresponds to the findings of Ndayishimiye et al. (2024), who demonstrated that in Central and Eastern Europe, provider-payment reforms succeed when implementation systems, performance indicators, tariff design, and stakeholder coordination are aligned. In other words, our results suggest that financial sustainability is not simply a fiscal outcome, but an institutional outcome of how financing rules are designed and operationalized. Another important implication concerns the relationship between indeterminacy and sustainability. In our estimations, the indeterminacy

index became more important when broader time effects were controlled for, which suggests that environmental instability is not merely background noise, but a structural determinant of financial sustainability. This is compatible with the Ukrainian-focused literature emphasizing that wartime adaptation, financing reform, and public management restructuring must be considered jointly.

Volkova et al. (2024) argue that the Ukrainian financing model must adapt to institutional realities rather than mechanically borrow external solutions, while Hlushchenko (2025) stresses the growing importance of transparency, proper classification of financial flows, and the adaptation of financing instruments to wartime conditions. Our adaptive scenario is fully consistent with this view. It shows that sustainable improvement is achieved not by increasing expenditure alone, but by combining stronger public funding, lower household financial burden, and better technological and managerial adaptability.

At the same time, the study has several limitations that should be explicitly acknowledged. First, the cross-country panel is limited to Central and Eastern European countries, and therefore, the results are most applicable to systems with a comparable post-socialist institutional trajectory. Second, the integral index is based on macro-level indicators and thus cannot fully capture differences in quality of care, territorial inequalities, or provider-level efficiency. Third, the scenario component for Ukraine necessarily simplifies reality by operationalizing military pressure and technological adaptability through generalized indices rather than through a richer set of micro-level variables. Fourth, while the article identifies statistically meaningful associations, it cannot fully resolve the causal complexity of wartime public finance, especially where macroeconomic shocks, institutional reforms, and emergency interventions overlap in time. Therefore, the results should be interpreted as a robust comparative and policy-oriented framework for strategic assessment, but not as a final and exhaustive representation of all dimensions of health system performance.

CONCLUSIONS

As a result of the study, scientific approaches to the interpretation of the financial sustainability of the health care system in conditions of crisis and structural shocks were generalized. It was established that the financial sustainability of the health care system is determined not only by the absolute amounts of financing, but also by the balance of sources of revenue, the level of state participation in financing, the budgetary priority of health care, the degree of protection of the population from excessive private spending, and the ability of the system to adapt to military, macroeconomic, and technological challenges. Thus, financial sustainability appears as a complex characteristic that combines the budgetary, institutional, and social components of state policy.

A system of indicators has been formed to assess the financial sustainability of the health care system, and an integral index has been built on its basis. The feasibility of including 4 key indicators in its structure is justified, namely the share of current healthcare expenditures in gross domestic product, the share of domestic government expenditures in current healthcare expenditures, the share of government expenditures on healthcare in total government expenditures, and the share of direct household expenditures in financing the system. It is proven that such an index provides an opportunity to move from a fragmentary analysis of individual budget parameters to a generalized assessment of the financial sustainability of the healthcare system.

A cross-country panel of comparable data for the countries of Central and Eastern Europe was formed, which made it possible to conduct descriptive, correlation, and econometric analysis. It was established that the use of a balanced panel based on indicators from 12 countries and 108 country-year observations forms an appropriate analytical basis for comparing national healthcare financing models. The descriptive analysis confirmed significant inter-country differentiation in terms of the level of financial sustainability, the structure of financing sources, and the burden on households, which reflects the heterogeneity of the financial configurations of health care systems within the studied group of countries.

The impact of macroeconomic, crisis, and financial factors on the dynamics of the integral index of financial sustainability of the health care system was assessed. It was established that positive macroeconomic dynamics and anti-crisis fiscal mobilization can strengthen the financial sustainability of the system, while inflationary pressure, a high level of uncertainty of the external environment, and a significant direct financial burden on the population weaken it. At the same time, it was proven that the correct interpretation of the identified relationships requires taking into account not only the strength of shocks, but also the institutional ability of the state to adapt financial policy to the new conditions of the functioning of the health care system.

Scenario modeling of possible trajectories of the financial sustainability of the health care system of our country for 2026–2030 was carried out. The modeling results showed that the baseline scenario reflects a gradual but limited improvement in financial sustainability, the stressed scenario records the preservation of high vulnerability of the system even with an

DOI: 10.55643/fcaptp.2.67.2026.5218

increase in total costs, and the adaptive scenario demonstrates the best trajectory under the conditions of a combination of increased public funding, a decrease in the share of direct public spending, institutional improvement and more active use of artificial intelligence-based technologies in managing financial flows. Thus, the scenario modeling confirmed that the financial sustainability of the health care system is determined by the combined effect of budgetary, organizational, and technological factors.

Prospects for further research are associated with expanding the sample of countries, detailing indicators of the quality of medical services, and also with an in-depth assessment of the impact of artificial intelligence-based technologies on the efficiency of resource allocation, the quality of medical care, and social justice in the healthcare system.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

All authors have contributed equally.

FUNDING

The Authors received no funding for this research.

CONFLICT OF INTEREST

The Authors declare that there is no conflict of interest.

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ФОРМУВАННЯ ТА РЕАЛІЗАЦІЯ ДЕРЖАВНОЇ ПОЛІТИКИ ЗАБЕЗПЕЧЕННЯ ФІНАНСОВОЇ СТІЙКОСТІ СИСТЕМИ ОХОРОНИ ЗДОРОВ'Я В УМОВАХ НЕВИЗНАЧЕНОСТІ

У роботі досліджено теоретичні, методичні та прикладні засади формування й реалізації державної політики забезпечення фінансової стійкості системи охорони здоров'я в умовах невизначеності. Актуальність теми визначається тим, що система охорони здоров'я функціонує під впливом послідовного нашарування пандемічних, воєнних, макроекономічних і технологічних шоків, що вимагає переосмислення підходів до державного фінансування, бюджетного реагування та управлінської адаптивності. Метою дослідження є розробка теоретико-методичного підґрунтя й прикладного інструментарію для оцінювання фінансової стійкості системи охорони здоров'я й вироблення пропозицій щодо вдосконалення державної політики в цій царині. У роботі побудовано інтегральний індекс фінансової стійкості системи охорони здоров'я, оцінено вплив макроекономічних і кризових чинників на його динаміку, а також

DOI: 10.55643/fcaptp.2.67.2026.5218

сформовано базовий, напружений і адаптивний сценарії для нашої країни на 2026–2030 роки. Доведено, що стійкість системи охорони здоров'я визначається не лише масштабом державних витрат, а й структурою джерел фінансування, рівнем прямого фінансового навантаження на населення, стабільністю бюджетного пріоритету охорони здоров'я та здатністю держави впроваджувати технології на базі штучного інтелекту в управління фінансовими потоками. Практична цінність роботи полягає в можливості використання її результатів державними органами влади для вдосконалення бюджетної політики, розвитку програми медичних гарантій і формування адаптивних механізмів забезпечення фінансової стійкості системи охорони здоров'я.

Ключові слова: державна політика, фінансова стійкість, система охорони здоров'я, індетерміновані умови, державне фінансування, програма медичних гарантій, сценарійне моделювання

JEL Класифікація: I18, H51, C23, C53, O38