









# “Interaction between health insurance, household income, and public health financing in Ukraine”

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# INTERACTION BETWEEN HEALTH INSURANCE, HOUSEHOLD INCOME, AND PUBLIC HEALTH FINANCING IN UKRAINE

## Abstract

The most significant problems in financing the public health system in Ukraine are the permanent deficit of public spending on medicine and the shallow development of the voluntary health insurance market. The aim of study is the search of optimal interactions between stakeholders in the system of relations "state – insurance companies – households" in the context of voluntary health insurance. The study hypothesizes that households can become more active participants in health insurance only if their average monthly income reaches a certain threshold level. It is calculated based on the results of simulation games using the Brown-Robinson iterative method. According to the simulation results, this threshold level is only 7% higher than the actual value of the average monthly income of Ukrainian households during the analysis. At the same time, under this condition, the state in Ukraine will be able to transfer part of the financial burden of compensating healthcare costs to insurance companies. According to the calculations made with the help of the game theory toolkit, with the maximization of insurance payments to the population under health insurance contracts, the burden on public health financing in Ukraine could be reduced by 67.7%. The paper was conducted on the data of the ten most potent insurance companies of Ukraine as of 2021 (it is they who accumulate the lion's share of household insurance premiums), that is, before the start of a full-scale war between the Russian Federation and Ukraine. The obtained results can be used both by insurance companies during the management of insurance premiums and payments and at the level of state management of costs in the field of public health.

## Keywords

insurance market, health insurance, public health, insurer, insured, insurance payments

## JEL Classification

G20, G22, I13

## INTRODUCTION

Despite the active implementation of medical reform in Ukraine in 2017, which ideally should be aimed at reforming the primary and secondary healthcare levels, introducing the "money follows the patient" principle, thereby improving the quality of medical services, the situation was critical during periods of peak morbidity. It happened because Ukrainian medical institutions were not prepared for such a number of patients (limited bed capacity, lack of qualified medical personnel, special equipment, medicines, etc.). In addition, there was a need for more coordinated relevant protocols and communication channels and more personal and special protective equipment, especially among medical staff.

The experience of developed countries of the world (the USA and the United Kingdom) shows that the state cannot cover all citizens' medical services on a free-of-charge basis due to objective budget constraints. Moreover, the population cannot always pay for essential health examinations and treatment (the problem of access to medi-

cal facilities is particularly acute in rural areas). Therefore, for more full-fledged functioning of the healthcare sector, the state needs to develop the insurance market, in particular, its sector of voluntary health insurance. The current situation in the healthcare system confirms the feasibility of developing voluntary health insurance in Ukraine. Despite the constitutionally enshrined right of the population to access complementary medicine, the realities testify to the financing of most medical services at the expense of individuals.

In 2010, the Ukrainian government dominated the share of financing the healthcare system (56.5%). Then in 2015, the situation changed in favor of the private sector. As a result, as of 2019, the share of healthcare expenditures due to non-state funding sources exceeds budget funding by 5.7% and 52.5%. At the same time, the largest share in this category is household expenses (49.2% in 2020).

According to the State Statistics Service of Ukraine, in 2021, there was a much lower real GDP growth than expected, only 3%, due to the reduced gross added value in most activities. In addition, the unemployment rate of the working-age population of Ukraine increased to 10.3% in 2021, and the national poverty rate to 18%.

In this context, the following problem needs to be solved and is being actualized in Ukraine. First, it is necessary to reduce public health financing due to the activation of people to attract their financial resources in the field of health insurance. Second, there is a need to shift a part of the financial burden from the state to insurance companies.

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## 1. LITERATURE REVIEW

Numerous studies are devoted to the issue of voluntary health insurance market research. For example, Armstrong et al. (2010) and van Kleef et al. (2008) analyzed the risks and deductibles of health insurance in the Netherlands. Dror et al. (2016) and Panda et al. (2015) identified factors influencing the spread of health insurance programs in low- and middle-income countries, particularly India.

Wagstaff et al. (2009) studied the spread of a cooperative health insurance scheme in rural areas with the example of China. Ekman (2004) discussed the benefits of community-based health insurance for low-income countries. Madrian (1994) analyzed another form of employer-based health insurance, namely its impact on employee mobility. Finally, Dotsenko and Kolomiets (2022) conducted a similar bibliometric analysis of modern publications in the behavioral and social dimensions of the world's public health system.

Fedorova (2020) and Aleksandrov et al. (2021) considered the theoretical and practical aspects of state regulation of health insurance. In particular, a more advanced interaction model between

stakeholders of voluntary health insurance was proposed. Awojobi (2021, 2022) provides a detailed review of the evidence on the impact of the Social Health Insurance Scheme in Ghana and other African countries on improving access to healthcare, reducing poverty, and improving overall living standards. Finally, Mrabet et al. (2022) determined the relationship between indicators of quality of healthcare services and patient satisfaction with the health sector by the example of the survey results among patients in one of the towns of Algeria. It was found that patients have a positive perception of health services if they consider health services to be reliable.

Parkheta (2018) developed the methodological framework for defining health insurance as an additional source of financial support for healthcare. In addition, the study determined the level of concentration and competition in the market. She conducted a comprehensive study of health insurance in Ukraine – from the history of development and formation to the development of recommendations for voluntary health insurance and the introduction of mandatory health insurance as an additional source of healthcare financing in Ukraine. In addition to the studies mentioned above, which are directly related to the

health insurance problem, it is crucial to have a comprehensive picture of the insurance market as part of the financial sector. Thus, Brychko et al. (2021, 2022), Leonov et al. (2014), Lyulyov et al. (2021), and Yelnikova and Golochalova (2020) covered the financial sector environment in the context of the functioning insurance companies, as well as cover some determinants conditioning financial sustainability of the country's medical system. Scientists consider the concept of financial sustainability in the healthcare system and identify critical factors that affect it. They include the aging of the population, the emergence of new technologies, and the population's expectations regarding the quality of healthcare services. Didenko et al. (2020) attempted to build a structural model that makes it possible to identify the functional dependence between financial inclusion, behavioral aspects of the population, and social security issues. It is fundamental to adequately assess the level of willingness of the population to join the market of financial services, which includes health insurance services. The number of insurance premiums and payments in this direction were considered as determinants that identify the willingness of consumers to join the health insurance sector. Kuznyetsova et al. (2022) formulated a thesis about the importance of financial inclusion as one of the conditions for reducing poverty and integrating people with acquired health problems into the financial market due to establishing an accessible and open market for insurance medical services.

The management of the interaction between the insurer and the insured is based on the general rules of human resources organization. Gallo et al. (2019), Kadar and Reicher (2020), and Polinkevych et al. (2021) devoted their attention to studying basic health insurance schemes for employees, public and private organizations, and the unemployed. In addition, scientists have studied the behavioral aspects of defined categories as they interact. Kraft (2021), Rajan (2018), and Tsymbaliuk et al. (2021) testified to the growing interest of contemporary society regarding health-related issues and the active promotion of specific points in the development of management. They also identified the difficulties in implementing and prioritizing health and advancing training programs at the management level.

Kuznyetsova et al. (2021) explored the most vulnerable segments of the population (pensioners, homeless, and refugees). For example, in Rwanda and Peru, these are the national medical insurance systems for vulnerable population segments against the negative consequences of pandemics. Njegovanović (2020), Smiianov et al. (2020), and Hasan et al. (2022) considered the impact of the spread of epidemics, vaccination, and quarantine restrictions on the program of budgetary financing of medical care for the most vulnerable population groups. Lyeonov et al. (2021a) presented a model of a country's health profile (in the form of a four-pole barycentric model with balanced components) as an indicator to determine the prerequisites of whether the country is willing to combat and prevent mass disease. Such a profile will make it possible to balance the national healthcare financial system. Finally, Lyeonov et al. (2021b), using descriptive, canonical, and factor analyses, confirm the hypothesis regarding the functional dependence of the Ukrainian healthcare system on voluntary and mandatory health insurance.

Health insurance has also become more relevant nowadays due to global demographic processes. Sardak et al. (2018) identify and provide detailed characteristics for four global demographic processes: population growth, migration, tourism growth, and population structure changes in the context of their impact on forming the national health insurance system. It is impossible to imagine the insurance sector without modern technology trends. The innovative activities of insurance companies are based on four industrial revolutions. All this made it possible to transform healthcare services and adapt to new forms of medical care organization, for example, telemedicine, the context of their impact on forming the national health insurance system (Tiutiunyk et al., 2021, 2022; Yarovenko et al., 2021). The use of artificial neural networks, artificial intelligence, big data, and smartphone software is another promising direction of innovation that will improve the quality of information, consultation, and reference services in the health insurance field (Starostina et al., 2020; Vieriezubova & Levchenko, 2017; Zhuravka et al., 2021).

Despite numerous developments in this area, more attention should be paid to the issue of selecting the optimal model of behavior for choosing insur-

ance companies at the state and individual levels. Furthermore, the literature review emphasizes the importance of introducing and developing a health insurance system for Ukraine, which may become an alternative source of financing medical services, and additional financial protection for citizens, especially vulnerable groups, in case of disease.

In this regard, an important question needs to be resolved: What are the conditions under which households will want to intensify their participation in voluntary health insurance operations? This paper puts forward the hypothesis that the most necessary condition should be considered exceeding the average monthly household income of a certain threshold level, after which additional costs for health insurance will no longer significantly burden the family budget. In addition, understanding how effective the large-scale development of voluntary health insurance programs can be in saving budgetary costs for health care is also of scientific interest. In other words, if the average monthly income of households has reached this defined limit, what share of costs can be transferred from the state to insurance companies?

Simulation games were conducted using the Brown-Robinson iterative method to find answers to these questions. The provisions of game theory are based on two fundamental principles: research of individual behavior; based on the analysis of the behavior of many individuals, it is possible to study more complex phenomena. The use of game theory makes it possible to calculate possible options development of the economic process and determine the best steps, as well as take into account the behavior of opponents on the market (Samuelson, 2016; Iye & Onopchenko, 2014).

## 2. DATA AND METHODOLOGY

The voluntary health insurance market in Ukraine is moderately concentrated. According to the National Bank of Ukraine, the top 10 insurers of the “non-Life” category accumulate more than 50% of insurance premiums from individuals. That is why the main calculations were made on the data of the ten most potent insurance companies in Ukraine as of 2012–2021 (even before

the start of a full-scale war between the Russian Federation and Ukraine). Their list and value of insurance premiums and indemnities as of 2012–2021 are given in Table 1.

Using game theory requires a clear delineation of key actors (or, speaking in the language of game theory – key players). In the process of this study, the most important players are three parties: the government, insurance companies, and households (household income and public health expenditure will be used as input variables).

The analysis was carried out in the following sequence:

- 1) Stage 1: using linear regression analysis, build a dependence-based specification of the insurance payments volume on the household income level and the insurance premiums volume.
- 2) Stage 2: using linear regression analysis, build a dependence-based specification of the insurance premiums volume on the household income level and the insurance payments volume.
- 3) Stage 3: define using game theory (in particular, the Brown-Robinson iterative method):
  - the level of households’ average monthly income at which voluntary health insurance operations will be activated. In this case, insurance companies and households will act as players. Optimization modeling is carried out based on the assumption that the most optimal scenario is considered to be one in which the cost of insurance services for households is insignificant (minimization of insurance premiums), which allows for saving the family budget (household incomes are maximized);
  - the level of budget allocations for health care, at which the maximum amount of financial support is transferred from the state to insurance companies (that is, the amount of insurance payments from health insurance operations reaches its maximum level). In this case, the state and insurance companies will act as players.

**Table 1.** Key indicators of the top 10 insurance companies (as of 2021) for 2012–2021

Source: Forinsurer (2022).

| Top-10 Insurance Companies  | Years    |         |         |         |         |           | Average growth rate for the period |
|---|----------|---------|---------|---------|---------|-----------|------------------------------------|
|   | 2012     | 2014    | 2016    | 2018    | 2020    | 2021      |                                    |
| <b>Insurance premiums, thousand UAH</b>                           |          |         |         |         |         |           |                                    |
| UNIQA PrJSC IC  | 74,643.6 | 113,611 | 175,681 | 387,174 | 696,200 | 748,988   | 176.8%                             |
| PrJSC IC PROVIDNA   | 137,389  | 158,546 | 288,759 | 400,114 | 602,602 | 340,320   | 146.7%                             |
| INGO Insurance Company, JSC                                       | 93,578.8 | 75,970  | 125,498 | 187,075 | 440,607 | 499,121   | 157.7%                             |
| ARX IC JSC  | 32,881   | 57,425  | 181,798 | 224,674 | 348,788 | 689,692   | 192.5%                             |
| Insurance Company ALFA STRAKHUVANNYA PRAT (UKRAINE)               | 37,360.9 | 54,740  | 132,969 | 177,945 | 334,517 | 355,619   | 177.8%                             |
| Company with additional liability NAFTAGAZSTRAH Insurance Company | 268,398  | 325,258 | 241,523 | 248,961 | 223,327 | 55,556    | 97.1%                              |
| IC USG PJSC   | 33,528.6 | 59,304  | 88,497  | 131,820 | 222,377 | 501,021   | 160.9%                             |
| JS KRAYINA IC   | 23,557.0 | 13,640  | 92,910  | 125,574 | 208,294 | 152,099   | 260.0%                             |
| PJSC TAS Insurance Group  | 33,396.3 | 37,133  | 40,493  | 85,348  | 202,246 | 590,177   | 167.0%                             |
| PJSC Insurance Company PZU UKRAINE                                | 27,836.6 | 29,683  | 128,832 | 131,487 | 166,134 | 344,507   | 192.3%                             |
| <b>Insurance payments, thousand UAH</b>                           |          |         |         |         |         |           |                                    |
| UNIQA PrJSC IC  | 59,047.7 | 97,102  | 112,414 | 234,569 | 396,772 | 1,329,251 | 164.5%                             |
| PrJSC IC PROVIDNA   | 126,176  | 131,335 | 184,269 | 262,726 | 364,674 | 613,961   | 131.4%                             |
| INGO Insurance Company, JSC                                       | 112,550  | 86,999  | 70,708  | 114,790 | 230,910 | 928,249   | 130.5%                             |
| ARX IC JSC  | 21,102   | 30,468  | 89,305  | 154,280 | 161,894 | 1,341,418 | 178.8%                             |
| Insurance Company ALFA STRAKHUVANNYA PRAT (UKRAINE)               | 30,298   | 44,868  | 61,303  | 152,888 | 196,353 | 433,155   | 165.6%                             |
| Company with additional liability NAFTAGAZSTRAH Insurance Company | 170,834  | 194,970 | 163,844 | 178,659 | 103,864 | 107,813   | 91.3%                              |
| IC USG PJSC   | 19,893.8 | 53,963  | 48,756  | 92,942  | 130,884 | 2,791,624 | 173.3%                             |
| JS KRAYINA IC   | 16,499   | 17,710  | 61,541  | 89,840  | 133,087 | 354,308   | 187.2%                             |
| PJSC TAS Insurance Group  | 25,707.3 | 27,934  | 25,267  | 53,583  | 113,585 | 1,142,848 | 155.8%                             |
| PJSC Insurance Company PZU UKRAINE                                | 19,600.5 | 26,086  | 59,310  | 79,779  | 89,195  | 687,113   | 151.7%                             |

There are 10 possible scenarios (strategies) of decision-making proposed for each player. These scenarios are determined based on descriptive statistics (Table 2).

In general, there are analytical and approximate methods for performing matrix games. Analytical methods allow for determining the accurate result of the game in a finite number of steps. However,

**Table 2.** Descriptive statistics of the indicators

Source: Authors' calculations.

| Indicator          | Insurance premiums | Insurance payments | Household income | Healthcare expenditure |
|--------------------|--------------------|--------------------|------------------|------------------------|
| 1                  | 2                  | 3                  | 4                | 5                      |
| Average            | 170,402.3          | 109,615            | 7,474.322        | 94,010.67              |
| Standard error     | 32,319.25          | 17,335.97          | 1,103.477        | 13,418.53              |
| Median             | 149,696            | 87,671.7           | 6,238.8          | 75,503.4               |
| Mode               | 76,256.96          | 60,170.86          | –                | –                      |
| Standard deviation | 96,957.74          | 52,007.92          | 3,310.431        | 40,255.58              |
| Dispersion         | 94,000,000         | 27,000,000         | 10,958,956       | 16,200,000             |
| Kurtosis           | –0.39455           | –1.01362           | –1.43045         | 0.661689               |
| Skewness           | 0.883581           | 0.793109           | 0.597427         | 1.110715               |
| Minimum value      | 76,256.96          | 60,170.86          | 4,144.5          | 57,150.1               |
| Maximum value      | 344,509.2          | 192,121.8          | 12,432.3         | 175,789.7              |
| Sum                | 1,533,620          | 986,535            | 67,268.9         | 846,096                |

Note: *Ins\_Prem* – Insurance Premiums; *Ins\_Paym* – Insurance Payments; *House\_Inc* – Household Income; *Health\_Exp* – Healthcare expenditure.

depending on the complexity of the goal assigned, the period during which the optimal solution will be found may be considerable, and the process of finding the solution itself will require much effort. One of the analytical methods for solving game theory problems is the Brown-Robinson method. It has gained popularity because it is used to develop strategies for companies in an oligopolistic market, as well as for planning product ranges (Samuelson, 2016; Iye & Onopchenko, 2014).

The first step is to form the assumption that player A, with no information on player's B choice, randomly chooses a particular pure strategy  $Ax_1$  ( $x_1 \in 1, \dots, m$ ). Then, since both players are guided by rational logic during the decision-making process, player B, being unaware of his predecessor's choice, chooses the strategy  $By_1$ , which will bring him the slightest loss.

In the second step, the player A already knows what the player B has chosen and assumes that player B will also apply the previous strategy while making his next step. Thus, player A, pursuing the goal of maximizing his winnings under the other player's strategy, chooses strategy  $Ay_2$ . There is a situation that corresponds to (1):

$$\alpha_{x_2y_2} = \max_{1 \leq i \leq m} \alpha_{iy_1} \tag{1}$$

Accordingly, the second player chooses a strategy that corresponds to (2):

$$\begin{aligned} \beta(Q(1)) &= \max_{1 \leq i \leq m} H(A_i, Q(1)) = \\ &= \max_{1 \leq i \leq m} H(A_i, B_{y_1}) = \alpha_{x_2y_1}. \end{aligned} \tag{2}$$

Evaluating the situation, player B, taking into account the choice of player A in the first step, wants to minimize his loss under the available choice of pure strategy by player A, i.e., the strategy of player B.  $By_2$  corresponds to (3):

$$\alpha_{x_1y_2} = \min_{1 \leq i \leq m} \alpha_{x_1j} \tag{3}$$

If one writes down the pure strategy of player A as a mixed strategy (4), one can obtain the following efficiency index of strategy  $Ax_1$  (5):

$$P(1) = (p_1(1), p_2(1) \dots p_m(1)), \tag{4}$$

$$\begin{aligned} \alpha(P(1)) &= \min_{1 \leq j \leq n} H(P(1), B_j) = \\ &= \min_{1 \leq j \leq n} H(A_{x_1}, B_j) = \alpha_{x_1y_2}. \end{aligned} \tag{5}$$

The following step provides for considering the experience of the players' choice of strategies by the k previous steps. Mixed strategies of the following types

$$P(k) = (p_1(k), p_2(k) \dots p_m(k)), \tag{6}$$

$$Q(k) = (q_1(k), q_2(k) \dots q_n(k)). \tag{7}$$

are further considered. The frequencies of pure strategies  $p_i(k)$  and  $q_j(k)$  are determined by the corresponding formulas (8, 9).

$$p_i(k) = \frac{r_i(k)}{k}, \tag{8}$$

$$q_j(k) = \frac{t_j(k)}{k}, \tag{9}$$

where  $r_i(k)$  and  $t_j(k)$  are the number of occurrences of the strategies  $A_i$  and  $B_j$  respectively in the previous k steps.

Thus, the player A will choose the  $Ax_{k+1}$  strategy, pursuing the goal to maximize the payoff, that is, the study obtains (10, 11):

$$\begin{aligned} \beta(Q(k)) &= \max_{1 \leq i \leq m} H(A_i, Q(k)) = \\ &= H(A_{x_{k+1}}, Q(k)). \end{aligned} \tag{10}$$

The player B will accordingly follow the strategy, which minimizes his loss (9).

$$\begin{aligned} \alpha(P(k)) &= \min_{1 \leq j \leq n} H(P(k), B_j) = \\ &= H(P(k), B_{y_{k+1}}). \end{aligned} \tag{11}$$

The lower price of the game is defined as  $\max_{P \in SA} \alpha(P)$ , that is the maximum value of all efficiency indices of mixed strategies of player A. The upper price of the game is determined similarly as  $\min_{Q \in SB} \beta(Q)$  or the minimum of all inefficiency measures of mixed strategies of player B. In this case, the paper refers to the basic Neumann theorem (12), according to which:

$$\alpha(P(k)) = \max_{P \in S_A} \alpha(P) = \overset{V}{\Leftrightarrow} =$$

$$= V = \underset{V}{\Leftrightarrow} = \min_{Q \in S_B} \beta(Q), \tag{12}$$

where  $\overset{V}{\Leftrightarrow}$  the lower price of the game,  
 $\underset{V}{\Leftrightarrow}$  the upper price of the game.

If at a certain  $k$  level the equality

$$\alpha(P(k)) = \beta(Q(k)), \tag{13}$$

is satisfied, this means that the price of the game is found, and the corresponding strategies are optimal. Thus, the solution to the situation will take the form

$$\{P(k), Q(k), V\}. \tag{14}$$

### 3. RESULTS

With the help of regression analysis, a specification of the dependence of the volume of insurance payments on the level of household income and the volume of insurance contributions was built (15):

$$Ins\_Paym = 1,329.559 +$$

$$+0.191 \cdot Ins\_Prem + 10.141 \cdot House\_Inc. \tag{15}$$

Ten scenarios were created, describing different states of the interaction of players in this case: households and insurance companies. Given that the minimum wage in Ukraine in 2021 is 6500 UAH, this value is taken as the starting state in the modeling process.

Each subsequent state was formed when building scenarios, taking into account the step in 1,000 UAH. Therefore, a game (payment) matrix of dimension 10 by 10 is formed, consisting of simulated insurance premiums values (Table A1). So, for the level of household incomes, it is suggested to choose an interval from the minimum value (6,500 UAH) reached in 2021 to the maximum theoretically possible level in this model (15,000 UAH). Insurance premiums for these insurance companies are taken from Table 1 in 2021.

A total of 100 iterations were conducted in the study, a fragment of which is presented in the ap-

pendices (Table B1). As can be seen from Table A1, to ensure the activation of households regarding their participation in voluntary health insurance operations, the level of their average monthly income must exceed the limit of 15,000 UAH. As of 2021, the average monthly income of Ukrainian households was 14,200 hryvnias (at the same time, the minimum is 6,500 hryvnias). So more is needed to reach the threshold level of 15,000 UAH. Therefore, one should expect an increase in the inclusion of the population in voluntary health insurance operations by only 7%. If a full-scale war between Russia and Ukraine had not started at the beginning of 2022, achieving such a slight increase in the average monthly income of Ukrainian households would be realistic. For this, all the necessary prerequisites were formed in the economy at that time. Unfortunately, the increase in this income does not look realistic during military aggression. Based on the results of iterative modeling, under the condition that the average monthly income of households will increase to 15,000 UAH, the insurance services of PJSC Insurance Company PZU UKRAINE will be the most optimal for clients with this or a higher income level.

With the help of regression analysis, a specification of the dependence of the number of insurance contributions, the number of state healthcare expenditures, and insurance payments were also built (16):

$$Ins\_Prem = -41676,1 +$$

$$+1,3Ins\_Paym + 0,8Health\_Exp. \tag{16}$$

In this case, ten scenarios describing different states of the interaction of players were formed: states (the possible amount of healthcare expenditures) and insurance companies. Given that the minimum volume of public healthcare expenditures in Ukraine was 57.2 bln UAH (2014) in 2012–2021, this value corresponds to the first state. The step to increase each subsequent state of households was chosen to be 20,000. Therefore, a game (payment) matrix of dimension 10 by 10, is formed, consisting of simulated insurance payment values (Table C1). Thus, for the level of public healthcare expenditures, it is suggested to choose an interval from the minimum value (57.2 bln UAH) achieved during the investigated time range to the maxi-



imum theoretically possible level in this model (237.2 bln UAH). Insurance payments for these insurance companies are taken as of 2021.

A total of 100 iterations were conducted in the study, a fragment of which is presented in Table D1. From the point of view of households, the optimal state of public spending on healthcare is the minimum level of *Health\_Exp* 10 – more than 66 bn UAH. In contrast, the healthcare burden should be transferred to the most successful insurance companies. It should be noted that the actual value of the state's expenditure on financing the healthcare sector of Ukraine in 2021 amounted to 204.2 bln UAH. In other words, if voluntary health insurance in Ukraine works at total capacity and insurance companies can absorb the maximum possible costs, the state budget will save almost 138.2 bln UAH (67.7%). Of course, this situation can only be considered an “ideal model,” a kind of upper threshold limit since, in reality, the maximum value of insurance payments is unrealistic for the market and not profitable for insurers.

However, if one assumes such a significant reduction in state spending on health care, the insurance services will be the most optimal for clients of UNIQA PrJSC IC.

## 4. DISCUSSION

The search for optimal interactions between stakeholders in the system of relations “state – insurance companies – households” in the context of voluntary health insurance is relevant because it contributes to the creation of an effective multi-channel healthcare financing system. It will reduce the burden of personal expenses of citizens for the necessary medical care (medical services), ensure its fair distribution and increase the protection of Ukrainians against financial disaster in case of illness. For the state, this will ensure the

high efficiency of the healthcare system, transparent mechanisms, and rules. The healthcare industry will become attractive for investment.

The approach presented in this paper has some significant advantages compared to the approach of Fedorova (2020), which also models the interaction between stakeholders of voluntary health insurance. In particular, the methodology proposed is built on open and accessible data both from the point of view of insurance companies and households and the state. As a result, it allows an accurate estimate of the ratio between the volumes of insurance payments and premiums in the health insurance field. At the same time, Fedorova's model is challenging to implement in Ukrainian realities due to the lack of necessary statistical data.

The approach presented in this study should also be compared with the healthcare financing model based on health insurance (Mazepa, 2020). It considers the critical functions of the state's financial system (formation, distribution, use, and control), but at the same time has a significant drawback – it needs to consider the position of consumers of insurance services. A decisive role in assessing possible risks in this sector is played by the financial readiness and involvement of the population in the voluntary health insurance market, manifested primarily through the average income of the people and the volume of relevant insurance payments. In contrast to Mazepa (2020), the approach proposed in this paper allows for determining the guidelines for the further activities of the insurer and the insured.

The results allow a new look at the state of voluntary health insurance in Ukraine. Furthermore, the built model can later be used to assess the situation in other Central and Eastern European countries, where the health insurance market is more developed.

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## CONCLUSION

The study found a threshold level of household income at which people are willing to actively participate in the insurance market and invest their financial resources in health insurance services. This level is determined by simulation of simulated games using the iterative Brown-Robinson method. According to the simulation results, the increase in average household income of 15,000 UAH every month would

enable the population to participate in insurance processes actively and invest their financial resources in health insurance. Therefore, PJSC Insurance Company PZU UKRAINE is the most attractive insurance company operating in Ukraine for clients with this or higher income levels.

In addition, in the conditions of a permanent deficit of public spending on medicine in Ukraine, it is critical to shift from the state to insurance companies at least part of the financial burden for the compensation of health care costs. Calculations carried out with the help of the game theory toolkit proved that if the health insurance market in Ukraine works at total capacity, that is, with the maximization of insurance payments to the population under health insurance contracts, the minimum amount of medical expenses that should fall on the shoulders of the state is as of 2021 66 bln UAH. At the same time, the actual level of these state expenditures in Ukraine in 2021 amounted to 204.2 bln UAH. In other words, due to the activation of health insurance, the state budget will save 138.2 bln UAH (67.7%). With this level of state financial support for the health care industry of Ukraine, the most attractive is the insurance company operating in Ukraine, UNIQA PrJSC IC.

The obtained results can be used both by insurance companies during the management of insurance premiums and payments and at the level of state management of costs in the healthcare.

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## APPENDIX A

**Table A1.** Payment matrix of the game, where insurance companies and households are the players

Source: Authors' calculations.

| Strategy            |       | UNIQA PrJSC IC    | PrJSC IC PROVIDNA" | INGO Insurance Company, JSC | ARX IC JSC        | Insurance Company ALFA STRAKHUVANNYA PRAT (UKRAINE) | Company with additional liability NAFTAGAZSTRAH Insurance Company | IC USG PJSC       | JS KRAYINA IC     | PJSC TAS Insurance Group | PJSC Insurance Company PZU UKRAINE |
|---------------------|-------|-------------------|--------------------|-----------------------------|-------------------|---|---|-------------------|-------------------|--------------------------|------------------------------------|
|                     |       | <i>Ins_Prem 1</i> | <i>Ins_Prem 2</i>  | <i>Ins_Prem 3</i>           | <i>Ins_Prem 4</i> | <i>Ins_Prem 5</i>                                   | <i>Ins_Prem 6</i>   | <i>Ins_Prem 7</i> | <i>Ins_Prem 8</i> | <i>Ins_Prem 9</i>        | <i>Ins_Prem 10</i>                 |
| <i>House_Inc 1</i>  | 6000  | 194,901.1         | 177,057.6          | 146,175.0                   | 128,670.7         | 125,950.1   | 104,752.9   | 104,571.8         | 101,887.0         | 100,734.0                | 93,849.6                           |
| <i>House_Inc 2</i>  | 7000  | 205,042.5         | 187,199.0          | 156,316.4                   | 138,812.1         | 136,091.5   | 114,894.3   | 114,713.1         | 112,028.4         | 110,875.4                | 103,991.0                          |
| <i>House_Inc 3</i>  | 8000  | 215,183.9         | 197,340.4          | 166,457.8                   | 148,953.5         | 146,232.8   | 125,035.7   | 124,854.5         | 122,169.8         | 121,016.8                | 114,132.4                          |
| <i>House_Inc 4</i>  | 9000  | 225,325.3         | 207,481.8          | 176,599.2                   | 159,094.9         | 156,374.2   | 135,177.0   | 134,995.9         | 132,311.2         | 131,158.2                | 124,273.8                          |
| <i>House_Inc 5</i>  | 10000 | 235,466.7         | 217,623.2          | 186,740.6                   | 169,236.3         | 166,515.6   | 145,318.4   | 145,137.3         | 142,452.6         | 141,299.6                | 134,415.2                          |
| <i>House_Inc 6</i>  | 11000 | 245,608.1         | 227,764.6          | 196,882.0                   | 179,377.6         | 176,657.0   | 155,459.8   | 155,278.7         | 152,594.0         | 151,441.0                | 144,556.6                          |
| <i>House_Inc 7</i>  | 12000 | 255,749.5         | 237,906.0          | 207,023.4                   | 189,519.0         | 186,798.4   | 165,601.2   | 165,420.1         | 162,735.4         | 161,582.4                | 154,698.0                          |
| <i>House_Inc 8</i>  | 13000 | 265,890.9         | 248,047.4          | 217,164.8                   | 199,660.4         | 196,939.8   | 175,742.6   | 175,561.5         | 172,876.7         | 171,723.8                | 164,839.4                          |
| <i>House_Inc 9</i>  | 14000 | 276,032.3         | 258,188.8          | 227,306.2                   | 209,801.8         | 207,081.2   | 185,884.0   | 185,702.9         | 183,018.1         | 181,865.2                | 174,980.8                          |
| <i>House_Inc 10</i> | 15000 | 286,173.6         | 268,330.2          | 237,447.6                   | 219,943.2         | 217,222.6   | 196,025.4   | 195,844.3         | 193,159.5         | 192,006.6                | 185,122.2                          |

Note: *Ins\_Prem* – Insurance Premium; *House\_Inc* – Household Income.

## APPENDIX B

Table B1. Fragment of iterative calculations to determine the optimal level of insurance premiums

Source: Authors' calculations.

| Number | Strategy                           | UNIQA<br>PrJSC IC  | PrJSC IC<br>PROVIDNA | INGO<br>Insurance<br>Company,<br>JSC | ARX IC JSC         | Insurance<br>Company ALFA<br>STRAKHUVANNYA<br>PRAT (UKRAINE) | Company with<br>additional liability<br>NAFTAGAZSTRAH<br>Insurance<br>Company | IC USG<br>PJSC     | JS KRAYINA<br>IC   | PJSC TAS<br>Insurance<br>Group | PJSC<br>"Insurance<br>Company<br>"PZU<br>UKRAINE" |
|--------|------------------------------------|--------------------|----------------------|--------------------------------------|--------------------|--|---|--------------------|--------------------|--------------------------------|---|
| 1      | House_Inc 1                        | 194,901.1          | 177,057.6            | 146,175                              | 128,670.7          | 125,950.1  | 104,752.9   | 104,571.8          | 101,887            | 100,734                        | 93,849.62   |
| 2      | House_Inc 10                       | 481,074.7          | 445,387.8            | 383,622.5                            | 348,613.9          | 343,172.7  | 300,778.3   | 300,416.1          | 295,046.5          | 292,740.5                      | 278,971.8   |
| 3      | House_Inc 10                       | 767,248.4          | 713,718              | 621,070.1                            | 568,557.1          | 560,395.3  | 496,803.7   | 496,260.4          | 488,206.1          | 484,747.1                      | 464,094   |
| ...    | ...                                | ...                | ...                  | ...                                  | ...                | ...  | ...   | ...                | ...                | ...                            | ...   |
| 98     | House_Inc 10                       | 27,953,745         | 26,205,085           | 23,178,588                           | 21,463,164         | 21,196,544   | 19,119,219  | 19,101,470         | 18,838,363         | 18,725,370                     | 18,050,702  |
| 99     | House_Inc 10                       | 28,239,919         | 26,473,415           | 23,416,035                           | 21,683,108         | 21,413,767   | 19,315,244  | 19,297,315         | 19,031,522         | 18,917,376                     | 18,235,824  |
| 100    | House_Inc 10                       | 28,526,092         | 26,741,746           | 23,653,483                           | 21,903,051         | 21,630,989   | 19,511,270  | 19,493,159         | 19,224,682         | 19,109,383                     | 18,420,946  |
|        | <b>Strategy</b>                    | <b>House_Inc 1</b> | <b>House_Inc 2</b>   | <b>House_Inc 3</b>                   | <b>House_Inc 4</b> | <b>House_Inc 5</b>   | <b>House_Inc 6</b>  | <b>House_Inc 7</b> | <b>House_Inc 8</b> | <b>House_Inc 9</b>             | <b>House_Inc 10</b>                               |
| 1      | PJSC Insurance Company PZU UKRAINE | 93,849.62          | 103,991              | 114,132.4                            | 124,273.8          | 134,415.2  | 144,556.6   | 154,698            | 164,839.4          | 174,980.8                      | 185,122.1   |
| 2      | PJSC Insurance Company PZU UKRAINE | 187,699.2          | 207,982              | 218,123.4                            | 228,264.8          | 238,406.2  | 248,547.6   | 258,689            | 268,830.4          | 278,971.8                      | 289,113.2   |
| 3      | PJSC Insurance Company PZU UKRAINE | 281,548.9          | 311,973              | 322,114.4                            | 332,255.8          | 342,397.2  | 352,538.6   | 362,680            | 372,821.4          | 382,962.8                      | 393,104.2   |
| ...    | ...                                | ...                | ...                  | ...                                  | ...                | ...  | ...   | ...                | ...                | ...                            | ...   |
| 98     | PJSC Insurance Company PZU UKRAINE | 9,197,263          | 10,191,120           | 10,201,261                           | 10,211,402         | 10,221,544   | 10,231,685  | 10,241,827         | 10,251,968         | 10,262,109                     | 10,272,250.8                                      |
| 99     | PJSC Insurance Company PZU UKRAINE | 9,291,112          | 10,295,111           | 10,305,252                           | 10,315,393         | 10,325,535   | 10,335,676  | 10,345,818         | 10,355,959         | 10,366,100                     | 10,376,241.81                                     |
| 100    | PJSC Insurance Company PZU UKRAINE | 9,384,962          | 10,399,102           | 10,409,243                           | 10,419,384         | 10,429,526   | 10,439,667  | 10,449,809         | 10,459,950         | 10,470,091                     | 10,480,232.83                                     |

Note: House\_Inc – Household Income.

## APPENDIX C

**Table C1.** Payment matrix of the game, where the players are insurance companies and the state

Source: Authors' calculations.

| Strategy           |   | <i>Health_Exp</i><br>1 | <i>Health_Exp</i><br>2 | <i>Health_Exp</i><br>3 | <i>Health_Exp</i><br>4 | <i>Health_Exp</i><br>5 | <i>Health_Exp</i><br>6 | <i>Health_Exp</i><br>7 | <i>Health_Exp</i><br>8 | <i>Health_Exp</i><br>9 | <i>Health_Exp</i><br>10 |
|--------------------|---|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|-------------------------|
| <i>Ins_Paym</i> 1  | UNIQA PrJSC IC  | 51.985                 | 53.585                 | 55.185                 | 56.785                 | 58.385                 | 59.985                 | 61.585                 | 63.185                 | 64.785                 | 66.385                  |
| <i>Ins_Paym</i> 2  | PrJSC IC PROVIDNA   | 47.812                 | 49.412                 | 51.012                 | 52.612                 | 54.212                 | 55.812                 | 57.412                 | 59.012                 | 60.612                 | 62.212                  |
| <i>Ins_Paym</i> 3  | INGO Insurance Company, JSC                                       | 30.423                 | 32.023                 | 33.623                 | 35.223                 | 36.823                 | 38.423                 | 40.023                 | 41.623                 | 43.223                 | 44.823                  |
| <i>Ins_Paym</i> 4  | ARX IC JSC  | 21.451                 | 23.051                 | 24.651                 | 26.251                 | 27.851                 | 29.451                 | 31.051                 | 32.651                 | 34.251                 | 35.851                  |
| <i>Ins_Paym</i> 5  | Insurance Company ALFA STRAKHUVANNYA PRAT (UKRAINE)               | 25.930                 | 27.530                 | 29.130                 | 30.730                 | 32.330                 | 33.930                 | 35.530                 | 37.130                 | 38.730                 | 40.330                  |
| <i>Ins_Paym</i> 6  | Company with additional liability NAFTAGAZSTRAH Insurance Company | 13.907                 | 15.507                 | 17.107                 | 18.707                 | 20.307                 | 21.907                 | 23.507                 | 25.107                 | 26.707                 | 28.307                  |
| <i>Ins_Paym</i> 7  | IC USG PJSC   | 17.419                 | 19.019                 | 20.619                 | 22.219                 | 23.819                 | 25.419                 | 27.019                 | 28.619                 | 30.219                 | 31.819                  |
| <i>Ins_Paym</i> 8  | JS KRAYINA IC   | 17.706                 | 19.306                 | 20.906                 | 22.506                 | 24.106                 | 25.706                 | 27.306                 | 28.906                 | 30.506                 | 32.106                  |
| <i>Ins_Paym</i> 9  | PJSC TAS Insurance Group  | 15.170                 | 16.770                 | 18.370                 | 19.970                 | 21.570                 | 23.170                 | 24.770                 | 26.370                 | 27.970                 | 29.570                  |
| <i>Ins_Paym</i> 10 | PJSC Insurance Company PZU UKRAINE                                | 12.000                 | 13.600                 | 15.200                 | 16.800                 | 18.400                 | 20.000                 | 21.600                 | 23.200                 | 24.800                 | 26.400                  |

Note: *Ins\_Paym* – Insurance payments; *Health\_Exp* – Healthcare expenditure.

## APPENDIX D

**Table D1.** Fragment of iterative calculations to determine the optimal level of insurance payments

Source: Authors' calculations.

| Number | Strategy       | Health_Exp<br>1   | Health_Exp<br>2      | Health_Exp<br>3                   | Health_Exp<br>4 | Health_Exp<br>5  | Health_Exp<br>6   | Health_Exp<br>7 | Health_Exp<br>8 | Health_Exp<br>9                | Health_Exp<br>10                         |
|--------|----------------|-------------------|----------------------|-----------------------------------|-----------------|--|---|-----------------|-----------------|--------------------------------|--|
| 1      | UNIQA PrJSC IC | 75.91043          | 74.95119             | 73.99194                          | 73.0327         | 72.07345   | 71.11421  | 70.15496        | 69.19572        | 68.23647                       | 67.27723                                 |
| 2      | UNIQA PrJSC IC | 123.7033          | 124.3434             | 124.9836                          | 125.6237        | 126.2638   | 126.9039  | 127.544         | 128.1841        | 128.8243                       | 129.4644                                 |
| 3      | UNIQA PrJSC IC | 171.4962          | 173.7357             | 175.9752                          | 178.2147        | 180.4541   | 182.6936  | 184.9331        | 187.1726        | 189.412                        | 191.6515                                 |
| ...    | ...            | ...               | ...                  | ...                               | ...             | ...  | ...   | ...             | ...             | ...                            | ...                                      |
| 98     | UNIQA PrJSC IC | 4,713.706         | 4,867.947            | 5,022.187                         | 5,176.427       | 5,330.668  | 5,484.908   | 5,639.149       | 5,793.389       | 5,947.629                      | 6,101.87                                 |
| 99     | UNIQA PrJSC IC | 4,761.518         | 4,917.359            | 5,073.199                         | 5,229.039       | 5,384.88   | 5,540.72  | 5,696.561       | 5,852.401       | 6,008.241                      | 6,164.082                                |
| 100    | UNIQA PrJSC IC | 4,809.33          | 4,966.771            | 5,124.211                         | 5,281.651       | 5,439.092  | 5,596.532   | 5,753.973       | 5,911.413       | 6,068.853                      | 6,226.294                                |
|        | Strategy       | UNIQA<br>PrJSC IC | PrJSC IC<br>PROVIDNA | INGO<br>Insurance<br>Company, JSC | ARX IC JSC      | Insurance<br>Company ALFA<br>STRAKHUVANNYA<br>PRAT (UKRAINE) | Company with<br>additional liability<br>NAFTAGAZSTRAH<br>Insurance<br>Company | IC USG PJSC     | JS KRAYINA IC   | PJSC TAS<br>Insurance<br>Group | PJSC Insurance<br>Company PZU<br>UKRAINE |
| 1      | Health_Exp 10  | 66.385            | 62.212               | 44.823                            | 35.851          | 40.330   | 28.307  | 31.819          | 32.106          | 29.570                         | 26.400                                   |
| 2      | Health_Exp 10  | 132.770           | 124.424              | 107.035                           | 98.063          | 102.542  | 90.519  | 94.031          | 94.318          | 91.782                         | 88.612                                   |
| 3      | Health_Exp 10  | 199.154           | 186.636              | 169.247                           | 160.275         | 164.754  | 152.731   | 156.243         | 156.530         | 153.994                        | 150.824                                  |
| ...    | ...            | ...               | ...                  | ...                               | ...             | ...  | ...   | ...             | ...             | ...                            | ...                                      |
| 98     | Health_Exp 10  | 6,505.706         | 6,096.778            | 6,079.388                         | 6,070.416       | 6,074.896  | 6,062.872   | 6,066.385       | 6,066.671       | 6,064.136                      | 6,060.965                                |
| 99     | Health_Exp 10  | 6,572.091         | 6,158.990            | 6,141.600                         | 6,132.628       | 6,137.108  | 6,125.084   | 6,128.597       | 6,128.883       | 6,126.348                      | 6,123.177                                |
| 100    | Health_Exp 10  | 6,638.476         | 6,221.202            | 6,203.812                         | 6,194.840       | 6,199.320  | 6,187.296   | 6,190.809       | 6,191.095       | 6,188.560                      | 6,185.389                                |

Note: *Ins\_Paym* – Insurance Payments, *Health\_Exp* – Healthcare expenditure.