

## **Public expenditures as a factor of goods availability, provided by healthcare: evidence from Ukraine**

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**Abstract.** *The article contains the testing of analytical techniques designed to clarify the connection between resources provision of commercial and public sectors of healthcare – on one turn and the amount of goods consumption, produced by healthcare by households – on other. The specify kind of production function was used, adopted for displaying the connection “inputs - outputs”, where the “inputs” unites not different resources, but costs occurred in different sectors of healthcare (in particular – in public and commercial sectors).*

*The research results have confirmed that resource provision of Ukrainian public sector of healthcare decreases amidst the growing load on the sector’s productive capacity. Also was confirmed hypothesis about the significant impact of public sector resource provision on the price of goods, provided by the commercial sector of Ukrainian healthcare.*

*In general, was highlighted that lack of resources provision of the widely available sector of healthcare might lead to circumstances, where expanding the consumption of goods supplied by the commercial sector of the healthcare is not due to, but contrary to the dynamics of incomes, as a forced form of adaptation to decline the financing of the public sector of the healthcare.*

*Such results would contribute to the better understanding connection between indicators of public and commercial sectors of healthcare development (their resources provision, physical outputs and valued outcomes) on one turn and level of population well-being – on other. That, in turn, is required for developing the social sphere reform theoretical background for the health care services by income, as it was recorded in many studies in the developed countries.*

**Keywords:** *healthcare, resource provision, relative prices, commercial sector, public sector, consumption, social outputs, social outcomes.*

**Raktažodžiai:** *sveikatos apsauga, išteklių tiekimas, santykinė kaina, komercinis sektorius, viešasis sektorius, vartojimas, socialinė produkcija, socialiniai rezultatai.*

## Introduction

In modern Ukraine, the state-funded offer of the goods provided to households free of charge (primary / vocational education, higher education by state order, services of public health institutions, etc.) and at non-market prices (housing and communal services, public transport, postal and stationary communications) remains a significant factor for population well-being. At the same time, the dynamics of resource provision of social industries' public sector (in particular – the public sector of healthcare) is dramatically divorced from the dynamics of population needs. Ukraine is one of the few countries in the world, which are characterised by the stagnancy of healthcare sector resource provision (WHO, 2019).

The resources of the commercial sector of healthcare, are formed by household expenditures, which in Ukraine, is almost entirely so-called “out-of-pocket” costs – direct consumers payments to the supplier of benefits. This fact in itself is a significant deviation from the trend, which is widespread in developed countries, where the reduction of the share of such expenditures as a part of health financing sources was recognised as one of the major tasks of the industry development (Ortiz-Ospina & Roser, 2019).

And dynamics of Ukrainian healthcare system outputs and outcomes are far from perfect too (Io Storto & Goncharuk, 2017). Thus the formation of reform policy in Ukraine requires the researches, aimed to define the factors, causing the actual level of social satisfaction with results of public and commercial healthcare sectors. In particular, what is the contribution of resource provision dynamics to changes in healthcare outputs and outcomes and what is caused by decreasing or growing of allocative and technical efficiency? What is the role of developing the commercial sector of Ukrainian healthcare in meeting of population needs in goods and services, provided by that industry? Are there relations of substitution or complementary between commercial and budget sectors of healthcare? The results of such research may improve the vision of the connection between the amount of resources, devoted to healthcare and social results. As well they contribute to better understanding the impact of resource allocation between budget and commercial sectors of Ukrainian healthcare on benefits, gained by society with the healthcare system.

The purpose of this study is to define the relations between the dynamics of resource provision of public and commercial sectors of Ukrainian healthcare – as a factor and social outcomes of healthcare – as dependent parameters.

The object of the research is healthcare system as the unity of public and commercial sectors, which are although closely connected (sometimes the same institution provides both services on a commercial basis and free of charge within the limits of state financing), yet have separate channels of resource provision and the spheres of interaction with consumers.

That allows us to investigate the relationship between the supply, demand, and scale of consumption of the goods supplied by the commercial and public sectors of Ukrainian healthcare. We don't highlight certain commodity groups within the output of healthcare sectors and strive found the signs of the dominance of the relations of complementary or substitution between sets of goods, created by public and private healthcare sectors as a whole.

A fairly simplified analytical toolkit has been applied to outline the prospects for its further refinement and adaptation in order to use the statistical base from different countries. The following forms of government influence as price regulation, regulations and product standards, and the rules of cooperation between the suppliers and consumers, etc., were not taken into account. It is not taken into account that not all products from the suppliers (goods and services supplied by the healthcare institutions to the end-users) are consumed by households. However, the specificity of Ukraine's conditions (the minimum prevalence of corporate medical programs) makes it possible to consider the second limitation in such a way that it cannot significantly affect the study results. With regard to the first limitation (the influence of institutional factors, first of all, such as regulatory acts and regulations), our attention is concentrated only on the study of the connection between the resource conditions of the commercial and public sectors of healthcare, and how they provide the population with the goods they supply.

## Literature review

We consider the activity of healthcare institutions, belonging to the public sector of Ukrainian healthcare as a realisation of government policy through the succession of the programs. Then the resource provision of such programs as a factor of their social outcomes is in the focus of our research. Thus, our article is grounded at first turn on a range of applied works, devoted to evaluating social implications of programs and policies. These works are aimed at a comprehensive assessment of the benefits and costs (welfare changes) of a wide range of individuals whose interests are affected by government programs or regulations (Nagarajan, 1997; Weiss, 1998; Chelimsky, 1997; Krause, 1996). The fundamental principle of such assessments is the using of value measure for various forms of manifestation of the social consequences of project and policy principles implementation: cost units express life expectancy growth and infant mortality rates, subjective satisfaction of community representatives or other interested groups, reduced risk of injury and frequency of occurrence of complications in diseases or reduction of premature abandonment rates (Io Storto & Goncharuk, 2017; Segev, 2005; Weiss, 1998). As both results and costs of projects become clear over long periods of time, the moments of costs and benefits do not coincide, the valuation techniques include discounting procedures and in many respects are similar to investment planning procedures (in particular, to calculate the net present value of projects).

Our research differs through the statement of the problem and, accordingly, is based on other methodological principles. In particular, it does not cover the whole complex of social consequences of the implementation of a particular project or a certain direction of economic policy and does not provide an integrated assessment of the welfare (welfare changes) of the target group as a result of the using of certain volumes of resources (rejection of available alternatives). It investigates the dynamics of only a separate component of well-being – the provision of the population with the goods supplied by the healthcare industry in connection with the scale of resources that, through public and commercial frameworks, come into the hands of its production entities.

Thus, our research determines the tendency to change in the level of goods provision of the population in connection with the trends of resource supply of industry, but it does not quantify the “costs/results”. This creates some benefits from the point of view of “replicability” of research results: such a methodology does not require defining of the exogenous parameters that are not caused by empirical data or theoretical framework and affect quantitative cost estimates and benefits (such as risk preferences, discount rate and other).

The methodological principle, which is common for works on “cost – benefits” analysis and our research, is using a market value of goods consumed as an indicator of population well-being. The concept of “consumer and producer surpluses” creates a basis for quantitative assessing the dynamics of well-being (Weimer & Vining, 2017). The more the consumer surplus, produced by a market interaction between producers and consumers, the more the level of well-being, gained by society, as a consumer of certain goods. Then we have a basis for treatment with two main factors of value goods created and consumed: the change in the total amount of goods produced and in relative prices of such goods. The rising of relative price on commodity group, at other equal conditions, means that a better condition for growth the producers surplus is created at a certain market and worse – for growth the consumers surplus. When the growth of the total amount of goods produced and consumed is growing – then, at other equal conditions, the rising of consumers surplus is observed (Weimer & Vining, 2017). Thus, the rising growth rate of the total amount of goods created and consumed and the keeping constant (decreasing) of relative prices would be considered as a sign of the desired aggregate social result of the functioning of certain industry (in particular – commercial sector of healthcare).

The specific features of efficiency evaluation for healthcare are considered in the range of works, where the way to define the cost of production, the outputs and outcomes and approaches to correctness their comparing are formulated.

The fundamental principle of efficiency evaluation, noted in such literature, is a displaying a connection between resources (inputs) and products (outputs) through some kinds of “production

function”: “Economists conceive the transformation of inputs into valued outputs as a ‘production function’, which indicates the maximum feasible level of output for a given set of inputs”. (Cylus, Papanicolas, & Smith, 2016: 9).

The indicators of costs, used in our article are analogous with a range of other works (Cylus, Papanicolas, & Smith, 2016; European Commission, 2019; Jacobs, Smith & Street, 2006) with only difference in separate considering of the total inputs for public and commercial sectors of healthcare. But such separate and using of two explaining variables (amount of resources, used in public and commercial sectors of healthcare) allows us to investigate relations between social outcomes, created by this two sectors and defining the ability of commercial sector development act as a substitute for goods, provided by public (government financing) sector.

The wide used form of function for displaying the “inputs – outputs” connection is “Cobb – Douglas” function, which suggests the multiplicative connection between explaining variables (Lu et al., 2016; Vanberkel et al., 2012). But such form of the function is justified when the explaining variables reflect the amount of different resources, used for the creation of goods by healthcare. If the aggregate results of different sectors of the industry are considered as a dependent variable, the additive form of interaction of explaining variables is more appropriate, as was used, for example, for reflecting the connection between “inputs” and “outputs” of the healthcare system (its structural part) in Xu et al. (2018).

Indicators of outcomes in our work differ, compared with most commonly cited publications. The “canonic” way to display the outputs of healthcare is to use the indicators, belonging to the group of physical outputs (e.g., number of doctor visit) or referring to the group of valued healthcare outcomes (e.g. years of life gained) (Cylus, Papanicolas, & Smith, 2016; European Commission, 2019). But both way has some boundaries and lacks applying.

The fundamental disadvantage, inherent to indicators of physical outputs is the existence of a gap between such indicators and real (valued) aims of society: “For example, labour productivity measures framework for thinking about health system efficiency such as patient consultations per full-time equivalent (FTE) physician per month ignore the many other inputs into the consultation, and the many outputs other than patient consultations produced by the physician. In effect, such partial measures create efficiency ratios using only a subset of the inputs and outputs. Here the output measure is partial in several senses: a physician may undertake many other activities; there are many other inputs into the patient’s care; and there is no information on the health gain achieved by the consultation” (Cylus, Papanicolas, & Smith, 2016: 11).

The size of any indicator, belonging to the group of healthcare “valued outcomes” are determined not only by parameters, which may be accounted by “inputs” variables and in general refer to the healthcare system. Thus, the considered as healthcare outcomes wouldn’t be attributed to the chosen set of “inputs” parameters: “While data availability and consistency are important constraints for the development of operational efficiency indicators, it is nevertheless important to highlight that using health system outputs as a proxy can lead to the development of indicators that may be prone to faulty interpretation. A large number of non-healthcare determinants (for which efficiency models should ideally try to adjust) beyond health system outputs contribute to the definition of health” (European Commission, 2019: 8).

The limitations, inherent to the Ukrainian statistic of healthcare performances prompted us to develop the special system of indicators for reflecting the relations between resource provision and social results of public and commercial sectors of the Ukrainian healthcare system.

The highlight of our approach to healthcare outcomes is the existence of a connection between the amount of resources, devoted to the public sector of the healthcare system and amount of goods, consumed by households through the supply of commercial healthcare institutions. The existence of substitution and complementarity relations between goods, created by different sectors of healthcare is highlighted by the broad range of literature, devoted alternative schemes of healthcare financing (European Commission, 2017; OECD, 2016; Thomson, S., et al., 2014). But the significance of such relations, especially rising in conditions, observing in Ukraine. In Ukraine, the resource provision of

public healthcare sector and quality of goods created by them do not meet society needs, and the analogous goods created by commercial sector play role of preferred but more expensive good for households which are forced to pay the prevailing part of healthcare cost in the form of “out-of-pocket” payment, through a critically low level of development of health insurance.

Significance of such relations as a factor of households spending structure (has been evaluated on the highest level of aggregation – in referring to the households spending as a whole) is highlighted in a broad range of works. For example, models where the determinants of the consumer spending structure are real incomes (consumer spending) and relative prices of commodity categories (Florida-PI and Florida-Slutsky), have a high explanatory capacity for national patterns of consumer behaviour (Clements & Qiang, 2003; Seale & Regmi, 2006).

While the Florida-PI model imposes a provision on the indifference of spending share for the  $i$ -th good to the dynamics of demand for  $j$ -th good (the elasticity of demand for the commodity group “ $i$ ” to the price change of any commodity group “ $j$ ” is taken as zero), the Florida-Slutsky model introduced a special expression that reflects the substitution effect of relatively more expensive commodity groups with relatively cheap: “Like the Florida-PI model, the Florida-Slutsky model has three components: a linear real-income term, a quadratic pure-price term, and a linear substitution term replacing the cubic term in the former model, that is:

$$W_{ic} = \alpha_i + \beta_i q_c + (\alpha_i + \beta_i q_c) \times \left[ \log \frac{p_{ic}}{\bar{p}_i} - \sum_{j=1}^n (\alpha_j + \beta_j q_c) \times \log \frac{p_{jc}}{\bar{p}_j} \right] + \sum_{j=1}^n \pi_{ij} \left[ \log \frac{p_{jc}}{\bar{p}_j} \right], \quad (1)$$

where:

$\alpha_i + \beta_i q_c$ , – an element to explain the impact of real income;

$(\alpha_i + \beta_i q_c) \times \left[ \log \frac{p_{ic}}{\bar{p}_i} - \sum_{j=1}^n (\alpha_j + \beta_j q_c) \times \log \frac{p_{jc}}{\bar{p}_j} \right]$  – an element to explain the impact of relative prices;

$W_{ic}$  – the share of the  $i$ -th category of goods in the household’s consumer budget;

$q_c$  – the natural logarithm  $Q_c$  that measures real income per capita;

$p$  – relative price, and  $\bar{p}_i$  – defined as the average geometric price of the  $i$ -th group of goods in all countries covered in the study;

indexes “ $c$ ”, “ $I$ ” and “ $j$ ”, identify, respectively, a country and particular group of goods;

$\pi_{ij}$  – represents Slutsky’s price factors, that is, the matrix of the price compensated coefficients for Slutsky’s elasticity (Muhammad et al. 2011: 7, 9).

So, the relations of complementary and substitution between aggregate groups of goods belong to the three most significant factors of households consumption structure. However, with regards to substitution (addition) relationship between the goods supplied by the commercial and public sectors of the industry, such a model cannot be applied, since the prices of goods supplied by the public sector are not defined. Their consumption sizes are conditionally estimated at the level of production and are not dependent on the choice of the consumer (determined only by the policy of budget expenditures).

Thus our research contains an attempt to clarify the presence or absence of signs of interdependent or complementarity between the goods supplied by the commercial and state sectors of the healthcare industry, with the use of simplified mathematical tools.

Our research develops popular approaches in the scientific literature to the analysis of the structure of consumption in two aspects. First, unlike research, where the structure of consumer spending is considered as the result of a rational choice of households, determined by income, relative prices and socio-demographic factors, it considered the significant impact of the government-sponsored supply of free goods on the structure of consumption, since the choice between market

good and good provided free of charge within the framework of state programs, cannot be described by the same models that describe the choice between alternative market goods.

Second, unfavourable macroeconomic conditions, which are powerful restrictions to the solvency of households, and financial capabilities of the budget, distinguish Ukraine as a country with a strong industrial base and developed social infrastructure, but for a long time cannot overcome the economic downturn. In the world, there are few countries, which, according to the results of 2018, have a smaller absolute size of GDP and GDP per capita than the size achieved in 1990. Therefore, the experience of Ukraine is a specific example of the adaptation of the public sector to a long-term reduction in funding, contrary to the global trend on healthcare industry financing (Ortiz-Ospina & Roser, 2019).

### **Methodology & methods**

Initial hypotheses of the study, which are subject to empirical verification, can be formulated as follows:

1. Are there any signs of the interchangeability between the goods supplied by the commercial and public sectors of the healthcare in Ukraine?
2. Are there any signs of the complementarity between the goods supplied by the commercial and public sectors of the healthcare in Ukraine?

In accordance with the formulation of the initial hypotheses, two arrays of indicators were formed to characterise:

1. The volumes of resources received by the commercial and public sectors of Ukrainian healthcare.
2. The provision of households with goods supplied by the commercial sector of the healthcare industry in Ukraine.

The resources of the commercial sector of Ukrainian healthcare are formed by household expenditures. In Ukraine, in terms of healthcare, this is almost entirely so-called “out-of-pocket” costs, that is, direct consumers payments to the supplier of benefits.

Accordingly, in order to determine the nominal size of household expenditures for the purchase of goods supplied by the healthcare industry, the data was used within the national accounts, “The households final consumption expenditure”, the section “healthcare spending” (NSSU, 2010 – 2019, on-line resource).

That quarterly data was seasonally adjusted with Hodrick-Prescott filter at the value of “ $\lambda$ ” parameter 1600, as recommended in (Choudhary, Hanif and Iqbal, 2013).

The resources of the public sector are formed by expenditures of the local and central budgets.

Accordingly, the data was used within the national accounts, “The government final consumption expenditure”, the section “healthcare spending” (NSSU, 2010 – 2019, on-line resource).

That quarterly data was also seasonally adjusted with Hodrick-Prescott filter at the value of “ $\lambda$ ” parameter 1600.

For transforming these two sets of data in constant price, the GDP deflator for the appropriate type of economic activity was used. Such an index allows us accurately enough to display the inflationary pressure on a certain type of economic activity (certain industry).

Thus, the “resource provision of the public sector of healthcare” defines the expenditures of the local and central budgets of Ukraine that meet the three conditions. First, they are carried out within the economic activity of government structures. Second, the scope of their use is localised by a combination of stages of creating a certain category of goods, rather than the creation of added value of a particular industry. For example, the cost of paying public utilities of public health facilities does not belong to the added value of healthcare but should be taken into account as the cost of resource support for the creation of health services provided by the state. Third, all forms of state participation in the expansion of the supply of a certain category of goods should be taken into account: costs of government production, public procurement, end-user subsidies (if the implementation mechanism

does not include subsidies as a part of individual consumer household expenditures), direct subsidies to producers, etc.

The second set of indicators is the characteristics of the provision of households with goods supplied by the commercial sector of the healthcare industry in Ukraine.

That set includes the following indicators.

Firstly, the households expenditures for the payment of goods supplied by the healthcare industry (quarterly) on a commercial basis. The nominal size of household expenditures was gained analogous with the indicator of commercial sector resources provision: the data was used within the national accounts, “The households final consumption expenditure”, the section “healthcare spending” (NSSU, 2010 – 2019, on-line resource). But to convert nominal values into real the specify indexes of consumer prices (ICP) for an aggregate group of goods, produced by the industry were used. It means that the ratio between indices of prices on resources, purchased by industry and indices of price on industry production determines the ratio “inputs – outputs” for the industry. The more rate of growth the indices of price on resources purchased – the stronger (in other equal conditions) the inflation burden on healthcare and higher (at other equal) the efficiency of using the industry’s resource potential. The higher the rate of growth of price on goods produced by healthcare – the better possibility, which industry has to shift the inflation burden on consumers, lower (at other equal) the real “outputs” and efficiency of using industry’s resource potential. Such approach (valuating conditions, which some industry has for reproduction their resource potential through the ratio of price indices on resource purchased and goods produced) is enough spread in the literature (Meier, 2000). The procedure of seasonal adjusting the quarterly data is analogous with used for defining the set of indicators of healthcare resource provision.

Secondly, the indices of relative prices for goods were produced by the commercial sector of the Ukrainian healthcare industry (calculated based on ICP, quarterly data was seasonally adjusted similar to data about households spending, with Hedrick-Prescott filter).

Our analysis does not use indicators that directly characterise the physical outputs of Ukrainian healthcare such as the number of physicians, a number of beds in a hospital institution, or others proposed in extensive literature (Cylus, Papanicolas & Smith, 2016; European Commission, 2019). We also assume that valued outcomes of healthcare, such as years of expected life, mortality rate by diagnosis-related group or rate of decreasing of preventable mortality (Cylus, Papanicolas, & Smith, 2016; European Commission, 2019) will be applied as a dependent indicator in our further researches. Such decision caused some limitations for the sphere of applying our results. In particular such database not applicable for evaluation of effectiveness dynamics in both public and commercial sectors of healthcare, same as for valuating the expected aftermaths for population health through allocation resources between public and commercial sectors of the healthcare industry. But such database allows us, in first approximation, to clarify the potential of

the commercial healthcare sector to unload the public sector of that industry and become more a substitute, than a supplement for the public sector of healthcare in Ukraine.

For empirical testing of the first hypothesis, the linear function was used, which reflects the connection between:

- dependent variable – base growth rate of real households consumption of goods, supplied by the commercial sector of healthcare ( $Y_1$ );
- explanatory variables - the base growth rates of real resources of commercial ( $X_1$ ) and public ( $X_2$ ) sectors of the healthcare industry.

According to the construction logic, it is analogous to the Working model (Working, 1943) but does not use a logarithmic representation of the values of factor variables. It is due to the fact that both explanatory and dependent variables are expressed in growth rates, which greatly increases the probability of a hypothesis about the linear nature of the connection and the constancy of absolute values of increments.

The Working model (Working, 1943) had been actively used to explain the dependence of changes in the consumption structure on household income before it was improved in Theil’s works,

which incorporated the terms into the model to reflect the effects of relative prices (Theil, 1987). Our research uses the similar improvement of Working model but with the simplified mathematical tools and prices of goods complements/substitutes (prices of goods with index “j” in formula (1)) are replaced by the indicator of resources provision of public healthcare sector ( $X_2$ ). But the sign of that parameter in our model and the “linear substitution term” in formula (1) has the same means: the positive – if the relations of complementarity are observed, and negative – if there are the relations of substitutions.

The mathematical specification of the function, used in our research looks like follows:

$$Y_1 = a_0 + a_1 * X_1 + a_2 * X_2, \quad (2)$$

where:

$a_0$  – is a constant term of the function, reflects the autonomous, independent from the factors included in the model, real growth rate of consumption of goods supplied by the healthcare industry;

$a_1$  – is the coefficient for the variable “the basic growth rates of the real scale of resource provision of the commercial sector of the health care industry” – reflects the marginal change in the real growth of consumption as a result of changes in the growth rates of real resources of the commercial sector;

$a_2$  – is the coefficient for the variable “the basic real growth rates of the scale of resource provision of the state sector of the healthcare” – reflects the marginal change in the growth of physical volumes of consumption as a result of changes in the growth rates of resources of the public sector.

The using of quarterly data allows us to get 40 values of every included variable (after seasonal adjustment) and build enough valued model on the base of not differentiated data.

The results of the model’s parameters evaluation are considered according to the following principles. First, in the case of the existence of a substitution relationship between the goods supplied by the commercial and state sectors of the Ukrainian healthcare, the coefficient at the second explanatory variable should be negative, and the greater the dependent variable’s elasticity on the second explanatory is, the greater the potential of the public sector becomes a substitute for the goods, supplied by the commercial sector.

If there is a complementarity relation between the goods provided by the commercial and state sectors of healthcare, then the coefficients of both explanatory variables should be positive by the sign. At the same time, the ratio of elasticity coefficients will reflect a comparative indicator of the efficiency of the use of resources in two sectors of the healthcare: the higher is the coefficient of elasticity of the dependent variable from the explanatory, then, on other equal conditions, the higher is the efficiency of the using of resources to increase the volume of consumption of goods supplied by the relevant sector of healthcare.

The second model is similar by mathematical form and explanatory variables, but as a dependent variable, the base index of relative prices for products of the commercial sector of healthcare is used ( $Y_2$  – base (first quarter of 2010 = 100 %) indices of sectoral relative prices for products of healthcare).

The results of the model’s parameters evaluation are considered according to the following principles. If there is a significant reverse causality between the dynamics of the public sector resources and the price dynamics, this is an indication that the expansion of resources provision of the public healthcare sector can significantly limit the growth of prices for the products of the commercial sector. It will be additional confirm of existing substitutional relations.

If there is a direct correlation between the volume of resources of the public sector and the dynamics of relative prices, this will be a sign of the complementarities between the goods supplied by the state and commercial sectors of the healthcare in Ukraine.

Consequently, a sign of the ability of the state sector of healthcare to limit the growth of the relative price of goods supplied by its commercial sector will be a negative coefficient at the second explanatory variable.

The more significant is this dependence (the higher is the partial elasticity of the dependent variable on the second explanatory variable and the greater explanatory ability of the model), the stronger are chances of the public sector to take over the functions of the commercial one.

Partial coefficients of elasticity in all models are calculated according to the formula:

$$E_i = \frac{a_i \times \bar{x}_i}{\bar{Y}}, \quad (3)$$

where:

$a_i$  – is estimation of model parameter;

$\bar{x}_i$  – is the mean of the explanatory variable for the retrospective period;

$\bar{Y}$  – is the mean of the dependent variable for the retrospective period.

Since both the dependent and the explanatory variables are expressed in growth rates, the form of the calculation of the mean is geometrical mean.

## Results

The dynamics of resource provision for both commercial and public sectors of Ukrainian healthcare and the provision of Ukrainian households by goods supplied by commercial sector of healthcare for the retrospective period 2010-2019 is described in Figure 1.

Regarding the resource provision of the public healthcare sector received during 2010-2019, it fluctuated in various directions. A dramatical decline already occurred in the first quarter of 2016, and after that point, the significant raising of growth rates of commercial sector outputs is observed. The rapid increasing of ICP for goods, provided by the commercial sector occurred even earlier, and after 2014 the growth rate of prices are higher than the analogous rate for sector's outputs. It might be considered as a sign of deficiency the productive capacity of the commercial healthcare sector to satisfy populations needs, dynamically growing, amidst the public sector resource provision deleting.

Besides, the rate of growth of commercial sector resource provision is significantly lower, than that sector's outputs growth, which indicates that the efficiency of resources using in the commercial healthcare sector has increased during the retrospective period, and at the end of 2019 it was higher by 84.3 % as compared to 2010. This assessment is determined by the extent to which the sectoral index of prices for goods that are supplied by the healthcare falls behind the industry's GDP deflator. After all, the nominal household expenditures determine real consumption (after decreasing in accordance to the index of consumers prices for the industry products), and real resources (after a decrease in proportion to the GDP deflator). The index shows that the industry suffered from inflation, not being able to shift the burden of higher prices on the resources acquired during its activities to consumers through sufficient price increases.

Thus the prevailing trends of healthcare sectors resource provision might be defined as follows.

The public sector resource provision is declining and has reached a level of 83.8 % compared to the first quarter of 2010.

The resource provision of commercial sector has slightly increased (135.3 % at the end of 2019 compared to early 2010), but the outputs of the sector (real amounts of households consumption of goods, produced by sector) was increasing faster (has reached 249.4 % compared to early 2010) and the price growth was the faster more (255.4 %).

As a result of these trends, the share of the state budget financing in the healthcare industry has decreased from near 70 % to less than 43 % of its total resource provision.

At the same time, the consumption of goods generated by the commercial sector of the industry has dynamically increased during the entire retrospective period, and in 2017 the real amount of consumption already exceeds the base year on 61.6 %.

Below there are the results of evaluating (by the LSM) the model parameters.

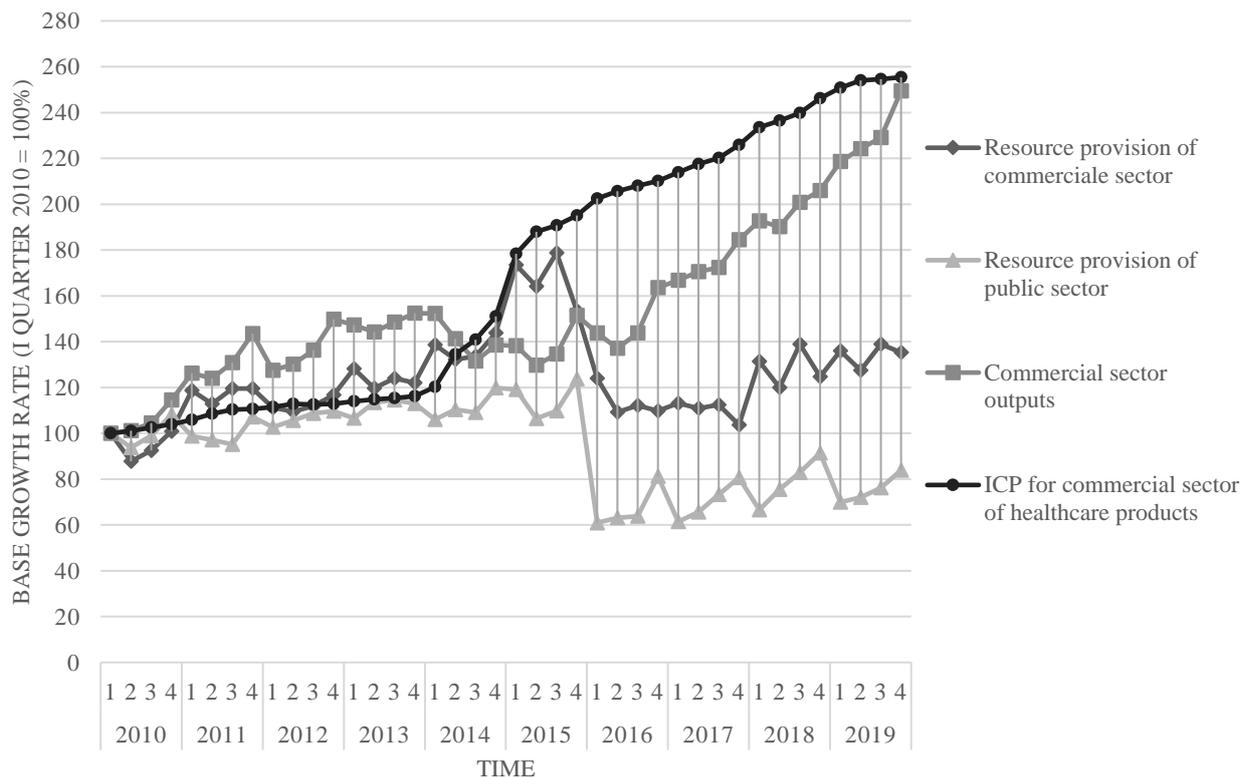


Fig. 1. The growth rate of resource provision for the public and commercial sectors of the healthcare, and the real growth rate of households spending on goods, supplied by the commercial sector of Ukrainian healthcare.

Source: Authors.

Estimation of model parameters was obtained by the first method of least squares (1LSM).

Matrix of estimates of model parameters was determined based on the equation (Nakonechny, et al., 2004: 97):

$$A = (X'X) - 1(X'Y) \quad (4)$$

where:

X – matrix of explaining variables;

X' – transposed matrix of explaining variables;

Y – matrix of dependent variables;

The first model reflects the dynamics of real consumption dependence on the scale of resource provision of the public and commercial sectors of healthcare.

The function's explaining capacity is mediocre (less than 50 % of the dependent variable value's variation is determined by the factor's variation according to the determination coefficient size – R<sup>2</sup>). The Fisher's criterion size makes it possible to recognise the model as meaningful (the determination coefficient estimate is non-random, and near the 50 % of the dependent parameter's variation is determined by the variation of the factors).

The estimation results are given in Table 1.

Table 1. The parameters estimates for model 1 (dynamics of resource provision for the public and commercial sectors as explanatory variables and real dynamics of consumption as the dependent variable).

Parameters	Parameter's estimate	t-statistic
a <sub>0</sub>	168.07	5.271

<i>Parameters</i>	<i>Parameter's estimate</i>	<i>t-statistic</i>
a <sub>1</sub>	0.788	3.327
a <sub>2</sub>	-1.185	-4.811
R <sup>2</sup>	0.423	
F	13.585 (> normative value for p = 0.05)	

Enough large ratios of parameters' values to their standard errors allow us to consider the estimates as reliable (this is evidenced by the bigger than the standard size of t-statistics). Thus, it is possible to consider the difference between the consumption elasticity on resource provision of the public and commercial sectors as not random. The elasticity of consumption of goods supplied by the commercial sector of healthcare to the resources provision of the commercial sector is 0.631. It means that the growth of real resource potential of the commercial sector by 1 % leads to an increase in the consumption of its products by near 0.6 %. Regarding the resources of the public sector, the elasticity is -0.717. It means that the expansion of resources provision of the public sector by 1 % causes almost 0.7 % reduction of consumption of the commercial sector's products.

The second function built with two same factor variables as first (real dynamics of resource provision of public and commercial sectors' of healthcare) but has the ICP on the products of the commercial sector of healthcare as the dependent variable.

The simulation results are given in Table 2.

**Table 2. The parameters estimates for model 2 (dynamics of resource provision of the public and commercial sectors as explanatory variables and ICP on goods supplied by the commercial sector – as a dependent variable)**

<i>Parameters</i>	<i>Parameter's estimate</i>	<i>t-statistic</i>
a <sub>0</sub>	204.979	6.31
a <sub>1</sub>	1.649	6.83
a <sub>2</sub>	-2.577	-10.26
R <sup>2</sup>	0.766	
F	60.685 (< normative value for p = 0.05)	

The explanatory capability of the model is strong enough (the determination coefficient is 0.766), while the F-criterion is more than standard, and the parameter estimates have low standard errors as evidenced by the adequate size of the t-statistics coefficients.

The coefficient near the variable "public sector resources growth rate" confirms the results obtained in the first model, and corresponds to the theoretical model: the expansion of the resource provision for the public sector reduces the demand for the goods supplied by the commercial sector (the coefficient is -2.577, and the elasticity coefficient for the relative price on goods provided by the commercial sector of the industry is -1.435). That is, according to the model, the expansion of resources of the public sector by 1 % reduces the growth rate for the relative price of the goods, supplied by the healthcare commercial sector by almost 1.4 %.

The expansion of the commercial sector resources provision by 1 % accelerates the growth rate for the relative price of the goods supplied by the commercial sector of the healthcare industry by almost 1.2 % (the elasticity coefficient is equal 1.215).

## Discussion

The first model (Table 1) should formalise the connection between the resource provision of the two sectors of the healthcare and the scale of consumption of its products. Accordingly, partial elasticity coefficients for each factor variable and signs of such coefficients should empirically justify the answer to the first basic questions of the study: how are the changes in the resource provision of

the two sectors of the healthcare industry associated with the scale of consumption of goods, supplied by the commercial sector of industry? And whether it is possible to detect a noticeable impact of the expansion or decline in the budget financing of the healthcare on the amount of goods, purchased by households from the commercial sector.

Almost equal elasticity of the dependent variable from the first and second explaining variable might be considered as a sign of the strong impact of resources conditions, inherent to the public sector on-demand on products of commercial sector. This is especially significant because the dynamics of the commercial sector resource provision affects the dependent variable directly, while resource provision of the state sector – indirectly, only by creating a more or less acceptable alternative to consumption of goods, created by the commercial sector.

It is important to take into account that the leading trends of the retrospective period are the reduction of the resource provision of the public sector of healthcare and the connection formalised in the model is more likely to express the specific form of adaptation to negative changes than the manifestation of expanding consumer choices, which is typical for most countries of the world during the same period (Ortiz-Ospina & Roser, 2019). Calculated coefficients of elasticity should not be interpreted as a sign of the possibility of gaining a social effect from the resources allocated between healthcare sectors, through their redistribution from budget financing in favour of commercial or inverse. Any decisions on such redistribution are impossible without taking into account social, moral and ethical aspects. The short retrospective period and the weight of many factors not taken into account in the model do not allow us to interpret the resulting quantitative values of elasticity as reliable for predicting the effects of resource flows between the state and commercial sectors of the healthcare. But major trends justified by modelling results are the dramatical reduction of the resource provision of the public sector, dynamically increasing of consumption of goods, produced by commercial sector with the faster growing of prices of such goods, which together indicate an increase in the intensity of the use of resource opportunities in the industry, in essence – the depletion of its resource potential.

The noted above indicates that Ukraine represents the very specific case of the connection between dynamics of resource provision and amount of consumption goods, provided by public and commercial sectors of healthcare (on the one side) and dynamics of population well-being. Referring to that connection, there is a fundamental relationship between the growth of income (consumer spending) and the diversification of the structure of such expenditures, mainly due to the overcoming the domination of food expenditures (Chai et al., 2014). In the context of this trend, it is established a close link between income growth and increased consumption of services in general and services in the healthcare industry in particular. In many works devoted to the dynamics of consumer spending structure, health spending has been classified as a luxury, that is, the size of their consumption grew faster than real income increased (Clements & Zhang, 2005). But in Ukraine, this universal pattern has a very specific character of demonstration. As the real size of consumer spending does not increase but have reduced over a sufficiently long period, expanding the consumption of goods supplied by the commercial sector of the healthcare industry is not due to, but contrary to the dynamics of incomes, as a forced form of adaptation to decline the financing of the public sector of the healthcare.

### **Conclusions and prospects of further research**

Observed characteristics of consumption of goods supplied by the healthcare industry are a form of adaptation to the critical shortage of resources for the development of both commercial and state sectors.

The replacement of the budget resource base with consumer spending is compelled because of a sharp reduction in budget funding and doesn't lead to decreasing of the load on the resource potential of the public healthcare sector, thus the improvement of the conditions for reproduction the productive capacity of sector is not observed.

The industry belongs to those that are strongly pressured by the intensity of the load on their resource potential because of the lagging growth of prices for healthcare's products from the rate of price growth on resources purchased by that industry.

The ratio of the calculated dependent variables elasticity on explaining factors is a sign of the problems of the budget sector: having the significant impact on the level of consumption the goods, produced by industry, that sector faced with a reduction of resource provision and worse conditions for potential resource reproduction. That poses a threat that the goods, created by the public sector would become "the worst good", and the growing of their consumption will indicate the decreasing of the well-being of the household caused by lack of budget, for getting access to goods, proposed by the commercial sector.

Clarification of the reasons for the better social outcomes of the resources using in the public sector, comparing with commercial (the elasticity coefficients for the public sector are higher than observed for commercial) requires further research that should take into account the differences in the structure of expenditures of medical institutions of the public and commercial sectors, wage levels and systems of motivation, principles of management and quality management, etc.

Estimates of the second model parameters correspond to the substitution relations between goods supplied by the state and commercial sectors of the healthcare. The coefficient near the variable "rate of expansion of the public sector resources provision" is negative. It is a sign that the growth of these resources limits the growth of prices on the goods provided by the commercial sector of healthcare. And the responsiveness of price level to resource provision of the public sector is higher, than to commercial which indicates the constantly significant impact of the public sector on the level of satisfying population needs in goods, created by healthcare.

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### **Valstybinės išlaidos kaip prekių prieinamumo faktorius, kurias teikia sveikatos priežiūros paslaugos: įrodymai iš Ukrainos**

#### *Anotacija*

Straipsnyje aptariami analizės metodai, skirti išsiaiškinti ryšį tarp išteklių teikimo privačiame ir viešajame sveikatos priežiūros sektoriuose. Yra nagrinėjami tiek sveikatos priežiūros prekių ir paslaugų suvartojimo rodikliai, tiek namų ūkių kiekis. Gamybos funkcija buvo naudojama vertinant funkcinį ryšius tarp sąnaudų ir produkcija. Šiuo atveju sąnaudos reiškia ne skirtingus išteklius, bet išlaidas atsitarančias skirtinguose sveikatos priežiūros sektoriuose.

Tyrimo rezultatai patvirtino, kad Ukrainos viešojo sveikatos priežiūros sektoriaus aprūpinimas ištekliais mažėja didėjant sektoriaus našumui. Taip pat buvo patvirtinta hipotezė apie didelį viešojo sektoriaus išteklių teikimo poveikį prekių kainai, kurią teikia Ukrainos sveikatos priežiūros komercinis sektorius.

Buvo identifiкуotas išteklių trūkumas reikalingas užtikrinti visuotinai prieinamas sveikatos priežiūros paslaugas. Tai gali įtakoti privataus sveikatos priežiūros sektoriaus pajamų augimą dėl vartotojų perėjimo dėl viešojo sektoriaus naujai apmokestinamų sveikatos paslaugų.

Šie rezultatai atskleidžia funkcinis ryšius tarp viešojo ir privataus sveikatos sektorių plėtros rodiklių. Šių rodiklių analizė yra būtina kuriant socialiai teisingą ir puikias sveikatos priežiūros paslaugas užtikrinančias sistemas sukurti.

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