# Evaluating the Effectiveness of Public Health Financing Based on Financial and Non-Financial Indicators in Terms of the Knowledge Economy

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***Abstract:***

*In conditions of the knowledge economy human capital, human value are the main factors of economic growth and prosperity of the state. Qualitative characteristics of human capital are indicators of public health. Therefore, one of the most important tasks of the state is to assess the effectiveness of financing public health expenditures.*

*The methodological base of the research was the methods of system and economic analysis, mathematical statistics and decision optimization, which resulted in the identification of factors influencing the resource supply, availability and quality of public health.*

*The formation of a comprehensive indicator of the effectiveness of the public health system based on the system of financial and non-financial indicators will allow to form numerically an assessment of the effectiveness of investments in public health and draw conclusions about the resources' provision, level of development, accessibility and quality of public health.*

*The obtained results can be used in making effective public financial decisions, which allow to achieve an increase of accessibility and quality of health care, focusing on the human capital in conditions of knowledge economy.*

***Keywords:*** *Financial Technologies, Fintech, Fintech-Branch, Investments, Banking, Blockchain-Technologies.*

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## 1. Introduction

One of the main tasks in analyzing the effectiveness of public health system financing is to assess the health and economic efficiency at various levels of government. However, there are still no common approaches to assessing the health and economic efficiency of not only the public health system in general, but also individual treatment and preventive institutions. Very often in various research works (Arrow, 1963; Anderson and Poullier, 1999; Kadyrov and Petrikov, 1995; Getzen, 2000; Berger and Messer, 2002; Alfonso and Miguel, 2005; Bokhari *et al.,* 2007; Blomqvist, 2011; Tae and Shannon, 2013; Kulkarni, 2016) the concept of efficiency is treated differently, and for this reason the estimated calculation methods are mixing. For example, Kadyrov and Petrikov (1995) cited the following definition: *"Efficiency is the measurement of the results obtained with the costs. The concept of "efficiency" characterizes the effectiveness of the tasks solved by any system in terms of resources spent on it. In other words, efficiency is the measurement of the obtained results with the costs. Performance is closely related to the concept of efficiency. Performance is usually understood as the degree of achievement of positive outcomes, the results without consideration of the funds spent on it. Thus, efficiency can be characterized as performance in comparison with cost".*

In the industry standard "Clinical and Economic Research" (2002), the term "efficiency" is interpreted as "the link between the achieved result and the resources used". However, this approach is very one-sided. The concept of "efficiency" is a multi-criteria characteristic that may not always be represented by one or few indicators.

*"Efficiency... in public health at the level of national economy is determined... by the degree of influence and impact on the preservation and improvement of public health, increase of labor productivity, prevention of expenses... on social insurance and social security, cost savings in the sectors of material production and non-production sphere, increase of national income growth "* (Manukhina and Artemyeva, 2012).

Efficiency in public health is the best choice of limited resources for the implementation of promising health-related programs. The assessment of the cost effectiveness in health care can be divided into 3 levels:

- ✓ Social effectiveness (characterized by indicators of public health- mortality from managed causes, primary occupational disability, etc.);
- ✓ Structural effectiveness (characterized by the indicators of the government benefits scheme on the types of medical aid- ambulance, stationary, outpatient, hospital-replacement);

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✓ Medical and economic effectiveness (characterized by indicators of achieving results in the treatment of certain diseases in the application of different methods and schemes of treatment).

At each level, one of the methods used in the practice of cost-effectiveness analysis can be used: method of cost minimization and "cost-performance" method. The first method- "cost minimization"-comes to solving a simple problem in choosing the cheapest option but is not limited to estimating costs. In the "cost-performance" method, funding comes to the ultimate goal, the result (e.g., an increase in life expectancy or a reduction in mortality) (Yashina *et al.,* 2017; Reinhard *et al.,* 2012; Chakraborty *et al.,* 2013; Gerdtham and Jonsson, 2000).

The main objective of the state's public health policy is to improve the health of the population by providing affordable medical care and improving the quality of medical services provided (Bitran, 2012; Bhalotra, 2007; Novignon *et al.,* 2012; Rajkumar and Swaroop, 2008; Thomson *et al.,* 2009). The formation of the unified system of medical and social insurance, as well as the improvement of the efficiency of the State regulation of the system; rational execution of the program of State guarantees of free medical care and development of regulations for the provision of free medicines to the population remain important (Rebba, 2014; Stabile and Thomson, 2014; Matt *et al.,* 2012).

## 2. Methodology and Data

### 2.1. Formation and substantiation of the system of indicators of health expenditure financing

The authors of this article propose the methodology of comprehensive assessment of the effectiveness of the State policy of financing public health services in regions of the Russian Federation. To this end, a number of factors have been developed to characterize the financing of the public health sector. Let's give a brief substantiation of the main ones.

1) Provision of the population with hospital beds

$$K_{phb} = \frac{Amount\ of\ hospital\ beds}{Population} * 10\ 000 \tag{1}$$

Where $K_{phb}$ is an indicator of the population's provision of hospital beds for every 10,000 people, unit of measurement: pcs.; *amount of hospital beds-* total number of hospital beds for each subject of the RF, unit of measurement: pcs.; *population-* number of inhabitants of each subject of the Russian Federation, unit of measurement: person. The hospital bed provision index is the most common measure of population satisfaction with stationary care.

2) Public provision of the doctors of all specialties

$$K_{pd} = \frac{Number\ of\ doctors\ of\ all\ specialties}{Population} * 10\ 000 \tag{2}$$

Where $K_{pd}$ - is an indicator of the population's provision of the doctors of all specialties for every 10,000 people, unit of measurement: person.; *number of doctors of all specialties*- the total number of doctors of all specialties for each subject of the RF, unit of measurement: person.; *population*- number of inhabitants of each subject of the Russian Federation, unit of measurement: person. The higher the specified rate, the more accessible to the majority of the population is outpatient care.

3) Capacity of outpatient organizations

$$K_{coo} = \frac{Number\ of\ visits\ per\ shift}{Population} * 10\ 000 \tag{3}$$

Where $K_{coo}$ - an indicator of the capacity of outpatient organizations for every 10 000 persons, unit of measurement: (visit per shift); *number of visits per shift*- total number of visits per shift for each subject of the RF, unit of measure: (visit per shift); *population*- number of inhabitants of each subject of the Russian Federation, unit of measurement: person. The indicator of outpatient organizations capacity shows the number of visits to outpatient organizations per a shift of 10 thousand people.

4) Load per doctor

$$K_{ld} = \frac{Population}{Number\ of\ doctors\ of\ all\ specialties} \tag{4}$$

Where $K_{ld}$ - the indicator of the load per one doctor, unit of measurement: person; *population*- number of inhabitants of each subject of the Russian Federation, unit of measurement: person; *number of doctors of all specialties*- the total number of doctors of all specialties for each subject of the RF, unit of measurement: person. The ratio shows how much the population falls on one doctor. The less this indicator is, the more accessible outpatient assistance is to the majority of the population.

5) Morbidity per 1000 population (registered diseases in patients with diagnosis, determined for the first time in life)

$$K_m = \frac{Number\ of\ first\ reported\ cases\ per\ year}{Population} * 1000 \tag{5}$$

Where $K_m$ - is an indicator of morbidity, the diagnosis of which is determined for the first time in life per 1000 people, unit of measure: (number of diseases); *the number of first reported cases per year*- the number for the first time in the life reported cases per year for each subject of the RF, unit of measure: (visit per shift);

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*population-* number of inhabitants of each subject of the Russian Federation, unit of measurement: person.

Shows morbidity per 1000 people who have a registered diagnosis for the first time in life. The lower the indicator, the lower the morbidity of population.

6) Average occupation of a hospital bed in a year.

$$K_{aohb} = 365 - (t * F)$$
$$F = \frac{Average\ number\ of\ days\ per\ year\ when\ hospital\ bed\ is\ occupied}{Average\ duration\ of\ hospital\ bed'soccupation} \tag{6}$$

Where $K_{aohb}$ - is an indicator of the average occupation of a hospital bed in a year, the unit of measure: days; t- number of days when the bed idle (due to repair or other circumstances), unit of measure: days; F- bed turnover, unit of measure: days.

The above coefficient shows how many days in a year a hospital bed is occupied in a health care facility. The indicator characterizes the scope of hospital activity and the efficiency of bed fund use.

7) Provision of the population with hospitals

$$K_{pph} = \frac{Population}{Number\ of\ hospitals} \tag{7}$$

Where $K_{pph}$ - is an indicator of the provision of the population with health care facilities, unit of measurement: person/number of hospitals; *number of hospitals-* the total number of health care facilities for each subject of the RF, unit of measure: pcs.; *population* - number of inhabitants of each subject of the Russian Federation, unit of measurement: person.

The indicator of the population's provision with hospitals shows how much of the population falls on one hospital. The lower the rate, the more effective the public health system is.

8) Expenditure of funds from Federal Compulsory Medical Insurance Fund (FCMIF) per capita

$$K_{eFCMIF} = \frac{Expenditure\ of\ funds\ from\ FCMIF}{Population} \tag{8}$$

Where $K_{eFCMIF}$ - an indicator of the expenditure of funds from FCMIF per capita, unit of measure: mln rub/person.; *expenditure of funds from FCMIF-* is the amount of spent money from FCMIF for each subject of the RF, unit of measure: mln rub.; *population-* number of inhabitants of each subject of the Russian Federation, unit of measurement: person.

This coefficient shows how much money was spent from FCMIF in the calculation for each resident of the subject of the Russian Federation.

9) Gross regional product (GRP) per capita

$$K_{GRPpc} = \frac{GRP}{Population} \tag{9}$$

Where $K_{GRPpc}$ - is the indicator of GRP per capita, unit of measurement: mln rub/person; *GRP*- total value of goods and services produced for each subject of the RF, unit of measure: million RUB.; *population*- number of inhabitants of each subject of the Russian Federation, unit of measure: person.

This coefficient shows how much of the final goods and services produced by the region's economy over a certain period of time are averaged per capita in the region (in value terms).

10) Health care costs to GRP

$$K_{EtGRP} = \frac{Health\ care\ expenditure}{GRP} \tag{10}$$

where $K_{EtGRP}$ -indicator of health care expenditure to GRP, unit of measure: shares; *health care expenditure* - the amount of health care costs for each subject of the RF, unit of measure: mln rub/person; *GRP*- Total value of goods and services produced for each subject of the RF, unit of measure: million RUB.

This indicator characterizes the share of public health financing from the general GRP on the subject of RF. The higher the number, the more money is being devoted to health financing in the region.

11) Nominal Wages of doctors

$$K_w = \frac{\sum Nominal\ wages\ of\ doctors\ of\ all\ specialties}{Number\ of\ doctors\ of\ all\ specialties} \tag{11}$$

where $K_w$ - is the nominal wage rate per doctor, unit of measure: rub; *nominal wages of doctors of all specialties*- the sum of nominal wage of doctors of all specialties on each subject of the RF, unit of measure: person.; *number of doctors of all specialties*- the total number of doctors of all specialties for each subject of the RF, unit of measurement: person.

This indicator characterizes the average nominal wage of doctors of all specialties on subjects of the Russian Federation.

12) Life expectancy

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$$K_{le} = \frac{\sum_{x=1}^{\omega-1} d_x * x}{L_0} + 0.5 \qquad (12)$$

Where $K_{le}$ – is an indicator of life expectancy on the subject of the RF, unit of measurement: years; $d_x$ - number of deaths at age of x; x- age in years; $L_0$- number of newborns on the table of survival.

This indicator characterizes the average life expectancy on subjects of the Russian Federation. The higher the rate, the more effective the health system is, since the increase in life expectancy is a key objective of the public health system sector.

## 2.2 Standardization of indicators and formation of the rating of territories on the level of health development.

Further, all of the above indicators are subject to standardization that is bringing the general view so that they can be compared to the subjects of the Russian Federation. The essence of standardization is that in the process of assessing the effectiveness of public health financing it happens to face the fact that the calculated indicators have different dimensions, importance or weightage. In this regard, a method based on linear conversion of initial index can be applied: For example, the values of standardized indicators will lie in a given interval from 0 to 1. Such standardization leads to loss of dimension, but the structure of changes in individual indicators is preserved, which makes it possible to compare and present them in a single coordinate system (Kornilov, et. al., 2017; Yashina, et. al., 2017). The following stages should be implemented in order to bring the indicators of the regions from the standardized form to the normalized one.

In the first phase, 3 conditional levels are chosen to characterize the health financing of the regions as follows:

Level 1: $K_{1\ level} = K_{max}$ (1.13)
Level 2: $K_{2\ level} = K_{average}$ (1.14)
Level 3: $K_{average} \geq K_{3\ level} \geq K_{min}$ (1.15)

In this case, the 1st level is characterized by effective values of the indicator; 2-nd level – moderate values of the indicator; Level 3 – ineffective values of the indicator.

In the second phase, the above three levels are selected for each indicator for each of the regions in question and each year.

In the third phase, the classification of indicators presented in section 2.1 is carried out in order to standardize them in two groups: "The higher the value of the indicator, the better" (for example, provision of the population with hospital beds,

provision of the population by doctors of all specialties, provision of the population by medical personnel, etc.) and "the lower the value of the indicator, the better "(capacity of outpatient organizations, morbidity per 1000 population, etc.).

For indicators with the value "the higher the value, the better" the following formula is used for normalization of the indicators:

$$K_{\text{the higher the better}} = \frac{K_i}{K_{2\text{ level}}} \qquad (13)$$

For indicators with the value "the less value of the indicator, the better" the rationing is made according to the following formula:

$$K_{\text{the lower the better}} = 1 : \frac{K_i}{K_{2\text{ level}}} \qquad (14)$$

Where $K_{\text{the higher the better}}$ — the normalized indicator for the indicators with the criterion "the higher the value of the indicator, the better"; $K_{\text{the lower the better}}$ — the standardized indicator for the indicators with the criterion "the lower the value of the indicator, the better"; $K_i$ - value of the indicator; $K_{2\text{ level}}$ - indicator with average value.

The position of each region is determined by the value of the aggregate normalized coefficient for the subject and compared with the corresponding value of the normative aggregate coefficient reflecting the normative value for the subjects, in the group of effective, moderate and ineffective health financing. Financing the public health of the region is considered the best if the indicator proves to be more than the value of the normative aggregate factor for a group of subjects with effective health financing. The cumulative standardized index for the analysis of health financing for each region is the sum of standardized indicators:

$$I_i = K_{n1} + K_{n2} + K_{n3\ldots\ldots} + K_{n16} = \sum_{i=1}^{16} K_{ni} \qquad (15)$$

Where $I_i$ — the cumulative standardized rate for a certain year $K_{ni}$ -normalized index. The greater the value of the cumulative standardized Health Financing index of the subject of the RF, the more effective it's financing is.

Further on each of the considered periods of time the ranking of indicators on the subjects of the RF is formed, that is, the rating from the highest value of the cumulative standardized index to the smallest aggregate ranked indicator is generated. Thus, the developed method allows to identify regions with effective, moderate and inefficient level of public health financing.

## 3. Results and Discussion

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The information source was provided by the data of the Federal State Statistics Service, namely the collections "Healthcare of Russia for 2015", "Russian Statistical yearbook", "Regions of Russia. Socio-economic indicators ", official reports of the Federal Treasury of the Russian Federation, as well as data of the Ministry of Finance of the Russian Federation for the period 2013-2015. It was investigated 85 regions of the Russian Federation, grouped by federal districts, and also 16 presented above analyzed indicators for the considered period of time (2013-2015 years).

Threshold normative values of the levels determining indicators of efficiency of health financing are established by the expert way on the basis of the most successfully developing and effectively working subjects of the Russian Federation, and also the maximal and the minimum scattering of the values of the indicator within the framework of the considered set of indicators of health financing efficiency on subjects of the Russian Federation. Indicators calculated on the formulas presented in the work (1.1-1.16) for standardization, for all subjects of the RF, are accepted as averaged throughout the territory and are presented as normative for the second level of effectiveness of public health financing.

Further, the consolidated integral indicator (1.22) is determined for each year of the period under review 2013-2015 for all subjects of the Russian Federation and an analysis of the effectiveness of public health financing is carried out.

The last step is the ranking of the final integrated indicators for each region of the Russian Federation and for each year studied. Ranking is a grading of all final integrated indicators in a strictly established order: from the maximum value to the minimum. Table 1 presents as an example the group of Russian constituent entities for 2013 in terms of the effectiveness of health financing based on a composite integrated indicator.

**Table 1.** *Ranking of subjects of the Russian Federation for 2013 on the level of effectiveness of public health financing (fragment)*

| No. Ser. No. | Period | Integrated Health Financing Effectiveness Indicator |
|---|---|---|
| | 1 level of public health financing effectiveness | 45.05 |
| 1 | Chukotka Autonomous District | 33.23 |
| 2 | Nenets Autonomous District | 30.77 |
| 3 | Magadan Region | 27.06 |
| … | … | … |
| 7 | city of Moscow | 21.89 |

| | | |
|---|---|---|
| … | | |
| | 2 level of effectiveness of public health financing | 16 |
| 1 | The Republic of Karelia | 15.85 |
| 2 | Irkutsk Region | 15.78 |
| 3 | The Primorye Territory | 15.51 |
| … | | |
| | 3 level of effectiveness of the public health financing | 13.77 |
| 1 | Vologda region | 13.76 |
| 2 | Volgograd region | 13.67 |
| 3 | Ivanovo region | 13.48 |
| … | | |

*Source: Authors' calculations based on the data of the Fund of obligatory medical insurance of the Russian Federation, the Federal State Statistics Service, the Ministry of Finance.*

Using the ranked tables for each year of the period under review 2013-2015 years, as well as rationed tables for the same years, an analysis of the effectiveness of public health financing is carried out.

Thus, the regions can be ranked by 3 levels: "first-class" subjects-the best from the standpoint of effectiveness of health financing; "second-class" subjects – are "acceptable" with satisfactory efficiency of health financing; the "worst" of the sample are on the third level.

### 4. Conclusion

Despite the fact that in this work the period under review covers only three years (2013-2015), to make a decision on the level of effectiveness of health care financing, this is sufficient, because the subjects of the Russian Federation, who are in the group of leaders practically do not change.

By conducting a consistent comparison of individual health care financing effectiveness indicators with regulatory maximum values, it is clear that most of the criteria have an approximate value to the recommended level. In particular, for example, the approximate values to the normative maximum indicator belong to the Nenets AD and Chukotka AD.

Thus, within the framework of this work the efficiency of healthcare financing of the Russian Federation subjects for the period of 2013-2015 years by means of calculation of the combined standardized indicator was determined. It is particularly noteworthy that the additional detailed examination of the analysis system indicators is the basis for improving the effectiveness of public health financing.

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