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## Evaluation of higher education services cost

**Abstract.** At present, the higher education in Ukraine is in conditions of fierce competition from foreign higher educational institutions. Hence, not only the quality of educational services should be significantly improved, but also the ways to increase the efficiency of the use of available resources, including funds provided to Ukrainian universities from the state budget for the training of specialists by state order. To perform the latter task, it is necessary to know the cost of training a specialist in a particular specialty.

The article presents the results of a comparative study of the cost of services in the field of higher education in Ukraine, depending on specialties (educational programs). The evaluations were compared by two methods. One of them is a «bottom-up» approach, in which statistical information was used to verify and analyze the information collected from Ukrainian universities which independently assessed the budgetary expenses for training specialists of various specialties, in particular, as part of their creation of budget requests. In another, the so called «top-down» approach, the regression model developed by the authors was used to determine budget costs for training specialists of various specialties.

The comparison of the results of these two approaches showed that in Ukraine, the state budget expenses for preparing a Bachelor of Socio-Economics degree in full-time education are higher than the corresponding expenses for preparing bachelors of technical specialties, despite the need for more valuable facilities and equipment for training of the latter. The gist of the problems is disclosed as the one caused by the existing system of distribution of state funds.

**Keywords:** Simulation; Higher Education; Higher Education Funding; Performance-based Funding; Cost of Higher Education Services; Cost of Bachelor Training

**JEL Classification:** C6; I21; I22; I23

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**Оцінювання вартості освітніх послуг для вищої освіти**

**Анотація.** Сьогодні сфера вищої освіти України перебуває в умовах жорсткої конкуренції з боку зарубіжних закладів вищої освіти. Отже, вона повинна суттєво покращити якість освітніх послуг і знайти шляхи підвищення ефективності використання наявних ресурсів, зокрема коштів, що надаються українським університетам з державного бюджету на підготовку фахівців за державним замовленням. Для виконання останнього завдання необхідно знати вартість підготовки фахівця за певною спеціальністю.

У статті подано результати порівняльного дослідження стосовно проведення оцінки вартості послуг у сфері вищої освіти України залежно від спеціальностей (освітніх програм). Порівнювались оцінки за двома методами. Один із них – підхід «знизу догори», в якому статистичними методами перевірялась

й аналізувалась інформація, зібрана від українських університетів, що самостійно оцінювали бюджетні витрати на підготовку фахівців різних спеціальностей, зокрема в рамках створення ними бюджетних запитів. В іншому підході, «згори донизу», для визначення бюджетних витрат на навчання фахівців різних спеціальностей використовувалася розроблена авторами регресійна модель.

Порівняння результатів двох підходів продемонструвало, що в Україні видатки державного бюджету на підготовку бакалавра соціально-економічного спрямування за денною формою здобуття освіти є більшими, ніж відповідні видатки на підготовку бакалаврів технічних спеціальностей, незважаючи на необхідність для навчання останніх коштовного матеріально-технічного забезпечення. Розкрито зміст проблем, що зумовлені існуючою системою розподілу державних коштів.

**Ключові слова:** моделювання; вища освіта; фінансування вищої освіти; фінансування на основі досягнутих результатів; вартість послуг вищої освіти; вартість підготовки бакалаврів.

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### **Оценка стоимости образовательных услуг для высшего образования**

**Аннотация.** На сегодняшний день сфера высшего образования Украины находится в условиях жесткой конкуренции со стороны зарубежных высших учебных заведений. Следовательно, она должна существенно улучшить качество образовательных услуг и найти пути повышения эффективности использования имеющихся ресурсов, в том числе средств, предоставляемых украинским университетам из государственного бюджета на подготовку специалистов по государственному заказу. Для выполнения последней задачи необходимо знать стоимость подготовки специалиста по определенной специальности.

В статье представлены результаты сравнительного исследования по проведению оценки стоимости услуг в сфере высшего образования Украины в зависимости от специальностей (образовательных программ). Сравнивались оценки по двум методам. Один из них – подход «снизу вверх», в котором статистическими методами проверялась и анализировалась информация, собранная от украинских университетов, которые самостоятельно оценивали бюджетные расходы на подготовку специалистов различных специальностей, в частности в рамках создания ими бюджетных запросов. В другом подходе, «сверху вниз», для определения бюджетных расходов на обучение специалистов различных специальностей использовалась разработанная авторами регрессионная модель.

Сравнение результатов двух подходов показало, что в Украине расходы государственного бюджета на подготовку бакалавра социально-экономического направления дневной формы обучения являются большими, чем соответствующие расходы на подготовку бакалавров технических специальностей, несмотря на необходимость для обучения последних дорогостоящего материально-технического обеспечения. Раскрыто содержание проблем, которые обусловлены существующей системой распределения государственных средств.

**Ключевые слова:** моделирование; высшее образование; финансирование высшего образования; финансирование на основе достигнутых результатов; стоимость услуг высшего образования; стоимость подготовки бакалавров.

## **1. Introduction**

Over the past decades, economic crises have exacerbated the problem of state funding of universities. A significant part of European countries has reported difficulties in funding universities (Singh, 2014) [1]. In this regard, in the field of higher education, economic reforms were launched to increase the financial autonomy of universities and help them survive in the conditions of a deficit of state funds and, accordingly, budget financing (Pruvot, Claeys-Kulik, & Estermann, 2015; Tilak, 2015) [2-3]. Researchers studying the economics of higher education argue that performance-based funding (PBF) can be one of the stimulating progressive tools (Miao, 2012; Ziskin, Rabourn, & Hossler, 2018) [4-5]. This approach to funding has gained popularity in Europe. PBF is considered an important tool for harmonizing budget funding to address the problem of improving the quality of higher education (Miao, 2012; Ziskin, Rabourn, & Hossler, 2018; World Bank, 2017) [4; 6]. However, the implementation of PBF requires solving two important local problems: determining quality indicators in this educational system and cost assessment of educational services. The use of PBF in budget funds allocation requires a detailed study of the current state of higher education state funding to ensure its further transformation (Auerbach & Edmonds, 2013) [7].

The peculiarity of the Ukrainian funding system of higher education is that almost all state and municipal higher education institutions (HEIs) have the status of budgetary institutions. These institutions are maintained by the state at the expense of the budget. All additional money earned independently

by such educational institutions, for example student fees, is credited to a special budget fund. Special funds are often used by universities to cover utility bills and support their development. Therefore, the study should take into account the availability of budget funds allocated to HEIs from the general fund of the state budget, funds from the special fund of the state budget (funds earned by the institution independently) and a number of other peculiarities of the budget funding of higher education. The obtained estimates of the cost of training a specialist for budgetary funds can be used to make justified managerial decision in order to improve economic relations in higher education.

## 2. Brief Literature Review

The analysis of recent studies was used to form the theoretical and methodological base of this work. The possibility of changing the approaches and models of higher education funding has been actively studied by foreign scholars, and this confirms the relevance of this issue for many countries with different levels of economic development. In particular, Tilak (2015) [3] and Singh (2014) [1] explored global trends in higher education funding; a range of alternative financing models of HEIs was studied by Auerbach and Edmonds (2013) [7]. Miao (2012) [4] from the Center for American Progress studied the features of performance-based funding model (PBF) in terms of the practice of using this method in six states of the United States. Dr. Maassen (2000) [8] explored various models of higher education funding applied in a number of European countries. A detailed report, supported by the World Bank, on the results of reforming financing and management in higher education was published by Johnstone, Arora and Experton (1998) [9]. In a comprehensive AHELO study conducted under the auspices of the OECD to search for effective international indicators of learning outcomes in higher education, Tremblay, Lalancette & Roseveare (2012) [10] found that economic growth in recent decades is insufficient to ensure the quality of higher education in conditions of constant growth in the cost of training. Hummell (2012) [11] analyzed the differences between the various models of HEIs financing used in the USA and other countries. Miller (2016) [12] focused on outcomes-based funding models and education quality. Ziskin, Rabourn and Hossler (2018) [5] investigated how the performance-based funding model (PBF) was used in Tennessee (USA), Washington (USA), Great Britain and Italy. Pruvot, Claeys-Kulik and Estermann (2019) [2] investigated effective HEIs funding strategies in Europe. Miroiu and Vlăsceanu (2012) [13] examined financing and education quality issues using Romania as an example. Pabian, Melichar and Šebková (2006) [14] presented an OECD study of the financing systems and their impact on higher education.

In Ukraine, systematic studies of economic problems of higher education are conducted by the Institute of Higher Education of the National Academy of Pedagogical Sciences [15]. The Institute's analytical materials have suggested some approaches to the implementation of PBF in Ukraine [16]. In the monograph [17], the Institute proposed a new model of economic relations in the higher education system.

The problems of financing higher education in Ukraine are researched by the Academy of Financial Management [18-19].

Relevant World Bank's surveys [20], materials from the Federal Statistical Office of Germany [21], research findings by Ukrainian scientists, in particular Y. Vitrenko, V. Vlasova, V. Vorona, V. Kiriienko and S. Melnyk [16], O. Musiienko [17], O. Spivakovskiy, T. Iefymenko, A. Sokolovska, S. Gasanov, O. Tymchenko, Y. Petrakov, O. Tereschenko, L. Oleznikova, L. Raynova and V. Kryvokhyzha [18], E. Malik and M. Bilinets [22], G. Kharlamova [23], S. Dziuba and N. Plotnikova [24], A. Lytvynchuk [25], I. Zhyliayev, V. Kovtunets and M. Somkin [26], S. Kalashnikova, V. Kovtunets, V. Luhovyy, I. Prokhor, V. Satsiuk and J. Talanova [27] and data on Ukrainina students abroad by CEDOS [28] were also used to formulate the theoretical basis for this study.

According to the research results, there was an increase in the level of budget expenditures on higher education in many countries over a certain period. However, later this level stabilized and began to decline. In order to ensure the development of higher education, it became necessary to search for other sources, methods and tools of effective funding. Since the 1980s, there has been a growing interest of universities in many countries in non-state (private) sources of income. The basis of the funding mechanism has changed from a focus on retention to a result orientation (Singh, 2014; Maassen, 2000; Tremblay, Lalancette, & Roseveare, 2012) [1; 8; 10]. In this context, formulas to calculate the amount of HEIs funding, as well as measures to link state funding to the activity of institutions have been developed in many European countries over the past 15 years. This trend is accompanied by modernization of monitoring and reporting procedures [23]. Reduction of state expenditures is carried out in parallel with the introduction of tuition fees (Tilak, 2005; Hummell, 2012) [3; 11].

The main trends in the financing of higher education in the world are the use of additional financial instruments - grants and student loans and the transfer of authority to the use of budgetary funds to universities while monitoring common measurable indicators (Johnstone, Arora, & Exper-ton, 1998) [9], the allocation of higher education costs between the state, students and their families through tuition fees and partial or full reimbursement of budgetary expenditures, application of the PBF funding model (Ziskin, Rabourn, & Hossler, 2018) [5]. The PBF model increases transparency, stimulates specific behaviour, requires the allocation of funds according to achieved performance (Miao, 2012; Auerbach & Edmonds, 2013) [4; 7]. Modern performance-based funding models are aimed at creating incentives and encouraging progress in achieving the stated goals, and are directly related to the state's needs for higher education recipients, with a strong emphasis on students' success, although they often include other parameters beyond students' learning progress (Miller, 2016) [12].

### 3. Purpose

The purpose of this study is to conduct a comparative evaluation of the cost of training funded by the state budget for a single specialist in a particular specialty or educational qualification level and form of training from the standpoint of two approaches: «bottom-up» (statistical evaluation) and «top-down» (regression modelling).

### 4. Results

#### 4.1. The need for transformation in the higher education system of Ukraine

The search for other financing models is relevant for Ukraine as well, because according to the World Bank comparative data, Ukraine spends a large share of national income on higher education compared to not only to developed but even post-Soviet EU countries [20; 22; 24] (Figure 1).

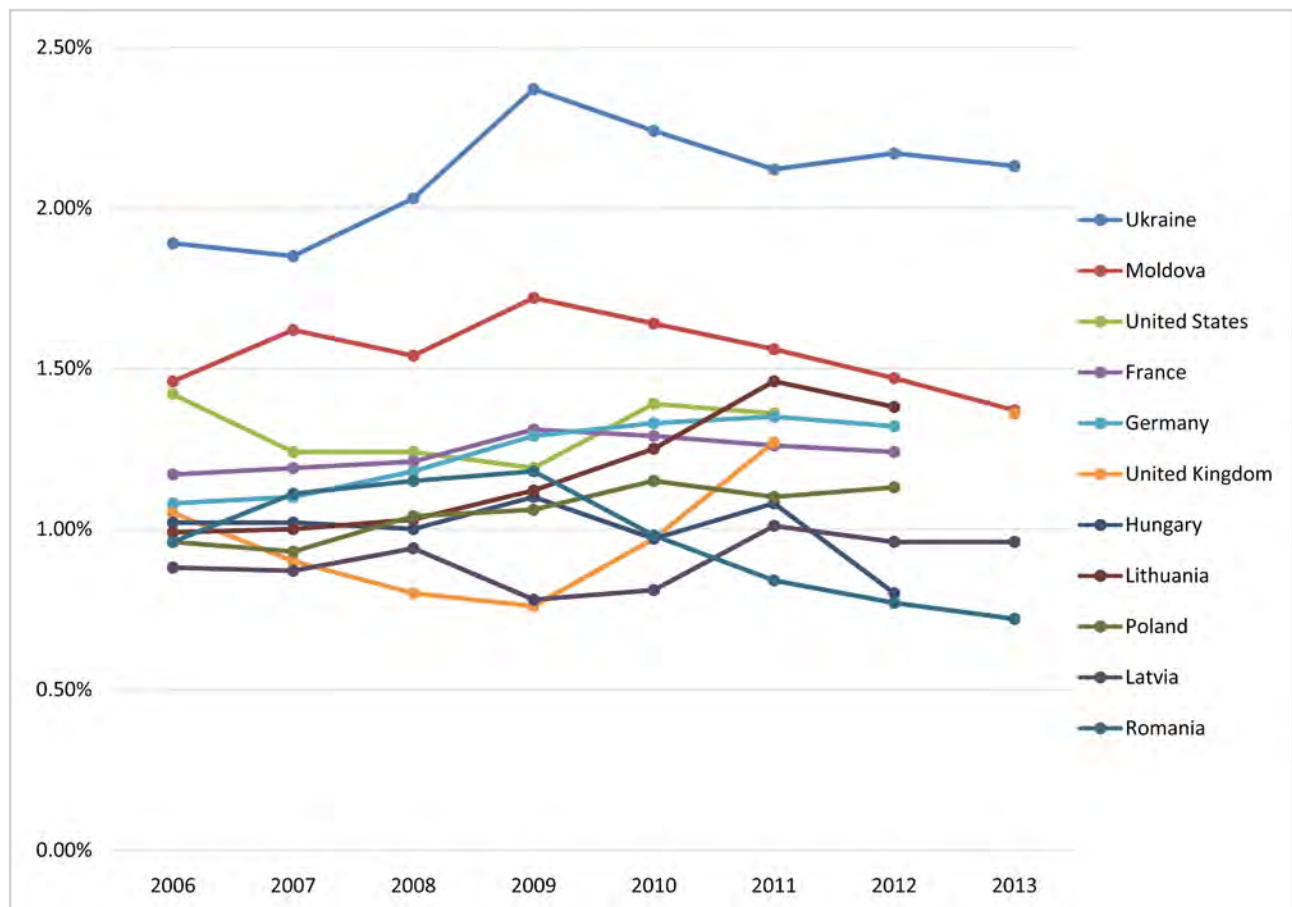


Figure 1:  
Government expenditure on tertiary education as a share of GDP in some countries  
Source: Our World in Data (2014) [20]



Today, the impact of various factors on the higher education sector of Ukraine is increasing. Indeed, it has been impacted by the global competition due to the reduction of barriers for Ukrainians to travel to other countries. Due to various circumstances, a significant part of Ukrainian families that have school-age children emigrate, more than 74,000 Ukrainian students study at foreign universities [28], about 40,000 of them in Poland [29]. This outflow of students reduces the amount of money that Ukrainian universities earn on their own.

The level of expenditures on education from the general fund of the state budget in Ukraine is also gradually decreasing. This is also due to the fact that in recent years other priority needs have emerged, including the military ones, which require additional resources.

Figure 2 shows the dynamics of education expenditures relative to the total consolidated budget of Ukraine (according to the State Treasury Service of Ukraine, [30]). A high level of spending on education was observed during 2009-2013, then its value began to decline. If in 2013 the share of these expenditures in the total amount of consolidated budget expenditures was 20.9%, in 2016 it decreased to 15.5%, and with regard to GDP - from 6.9% to 5.4%. The indicators for the year 2018 reveal a slight change in the downward trend for the upward trend; they are 16.8% and 5.9% respectively.

As for higher education, the share of higher education expenditures in the consolidated budget of Ukraine was constantly declining during 2014-2018: in 2014 this share amounted to 28.3% of the total expenditures of the consolidated budget, along with the following statistical data by year 2015 - 27.1%, 2016 - 27.2%, 2017 - 21.8%, 2018 - 21.1%.

Thus, although the reform of higher education in Ukraine was started with the adoption of the new Law «On Higher Education» in 2014, the basic economic and financial problems have not been solved. As a result, other components of the reform have also not been sufficiently successful. Ukrainian universities suffer from a shortage both self-earned and state budget funds. Nevertheless, a comparison at the macroeconomic level with other countries shows that the Ukrainian state allocates a larger share for universities than in other countries. From this standpoint, an increase in state funding can be considered unlikely.

At the same time, the legal regulation of the system of financing higher education does not comply with the constitutional norms, as well as the allocation of budgetary funds between higher education institutions is not regulated [19].

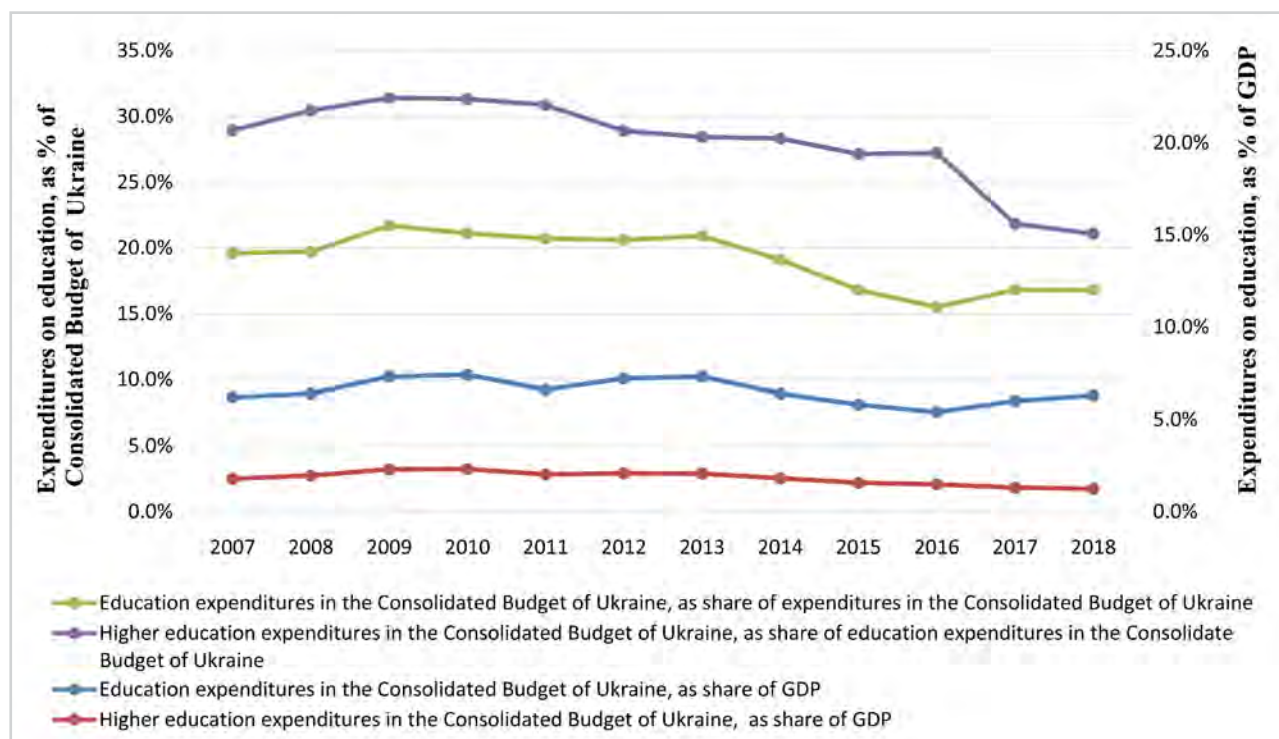


Figure 2:  
**Dynamics of the education expenditures in the Consolidated Budget of Ukraine and GDP, % (2007-2018)**

Source: The State Treasury Service of Ukraine data [30]

These trends indicate that the educational sector in Ukraine under the current conditions should be transformed to find ways to improve the efficiency of budgetary use and to improve the quality of educational services provided at these costs.

An urgent problem is the legal regulation of higher education funding in accordance with the norms of the Constitution of Ukraine: the transition from the maintenance of higher education institutions to the payment of educational services to persons who have obtained this right on a competitive basis, rationing the distribution of budgetary funds.

In general, in the field of higher education, the expert community has identified a number of the most pressing problems [26-27] that need to be addressed in the reform process. Within the framework of the discussion initiated by the Ministry of Education and Science of Ukraine, a number of transformations in the field of higher education were proposed. In particular, this includes the transition of HEIs to the status of non-profit organizations, multichannel financing with the expansion of the range of financial instruments used in a market economy, an increase in the degree of targeting of public expenditures and the implementation of a competency-based approach in higher education. These changes could stimulate competition for the best students, both between higher education institutions of Ukraine and foreign universities, and improve the quality of educational services in the market.

However, for a transparent justification of the principles of allocation of budget funds among the HEIs of Ukraine, it is necessary to improve or develop a method of evaluating the cost of higher education services, that is, to determine the cost for a higher education institution to train a single specialist of a certain specialty and educational qualification level, as well as corresponding form of training. The current legal framework in Ukraine [31; 35], unfortunately, does not provide an opportunity for an unambiguous assessment of the stated value. The direct use of international research results is not feasible either.

In connection with the abovementioned, research was initiated. Accordingly, collection of the necessary information became the basis for the formation of a methodology of cost evaluation of training a single specialist. Relevant information was collected through the use of information forms sent from the Ministry of Education and Science of Ukraine to the HEIs. The official reporting statistical and financial information from the HEIs was used for the calculations.

It should be emphasized that the cost of education services was evaluated by assuming that the higher education system has been relatively stable over a long period of time, and that the additional financing of higher education institutions (tuition fees paid by individuals and legal entities in the special fund of the State Budget) is less than half of the income in higher education institutions. The cost of the last educational service is generally less than the cost of the service at the expense of expenditures from the General Fund of the State Budget.

#### **4.2. «Bottom-up» approach.**

##### **Statistical evaluation of the training cost of a specialist in a particular field (specialty)**

The «bottom-up» approach is based on an independent calculation of the training cost of a specialist in a particular specialty by HEIs. Information tables were developed and sent to HEIs to be filled in. Information was centrally collected and statistically processed to eliminate possible erroneous data. An additional source contained self-calculated by HEIs data sets of the cost of a specialist training within the framework of the calculation, which is usually submitted by universities to justify the budget request in order to obtain budget funding. Such calculations were based mostly on the current methodological basis defined, in particular, by the Resolution of the Cabinet of Ministers of Ukraine «On Approval of the Methodology of Calculating approximate Training Cost of One Skilled Worker, Specialist, Postgraduate Student, PhD» as of 20 May 2013, No. 346 [31].

From the set of data characterizing the cost of training a specialist in a particular specialty, a sample was made, which usually covered about 80% of the data grouped around the weighted average by discarding data with very low and very high values. The criterion of the suitability of the data sample for further analysis was its proximity to the normal distribution. The value, which corresponded to the extremum of the distribution, was considered the average cost of training a specialist (full-time bachelor) for a particular specialty.

Different HEIs, as a rule, have different value of training a specialist in a particular field. This is due to the differences in qualifications and, accordingly, salaries of teaching and scientific staff that teaches, differences in facilities and their maintenance costs, differences in the maintenance of training laboratories equipment, etc.

Below are the results of the analysis for 2015-2017, obtained on the basis of information from about 150 Ukrainian HEIs, on the cost of training specialists in the context of the list of knowledge areas (specialties) defined in the Resolution by the Cabinet of Ministers of Ukraine as of 29 April, 2015 No. 266 «On Approval of the list of Knowledge Areas and Specialties under which higher education recipients are trained» [36].

Figure 3 shows the rankings of the weighted average cost of training full-time bachelors under the governmental contract in the context of knowledge sectors in the 2015-2016 academic year. Apparently, the most valuable were humanities areas of knowledge, such as Culture and Arts, Law, Humanities and Healthcare. Technical areas of knowledge took middle positions, while there is a sufficient demand for the specialists with technical degrees Architecture and Construction, Transport, Electronics and Telecommunications, or Automation and Instrument Engineering in the Ukrainian market. Among the cheapest was the training of specialists in high-tech industries, in particular, Mechanical Engineering, Chemical and Bioengineering, Electrical engineering and more. This structure of expenditures raises questions as it is necessary to have highly qualified teaching staff and a valuable modern laboratory base to train such specialists.

The results of similar calculations for the 2017-2018 academic year are presented in Figure 4. It can be seen that the cost of preparing a full-time Bachelor under the governmental contract in the 2017-2018 academic year compared to the 2015-2016 academic year generally increased. For example, for the most expensive education sector, Culture and Arts, there was an increase in UAH by 39.6%, and by 31.1% for the healthcare sector. It should be noted that the increase in the cost of educational services over the two years for different knowledge areas was different. Therefore, their arrangement in the ranking list (by value) slightly changed (Figure 3).

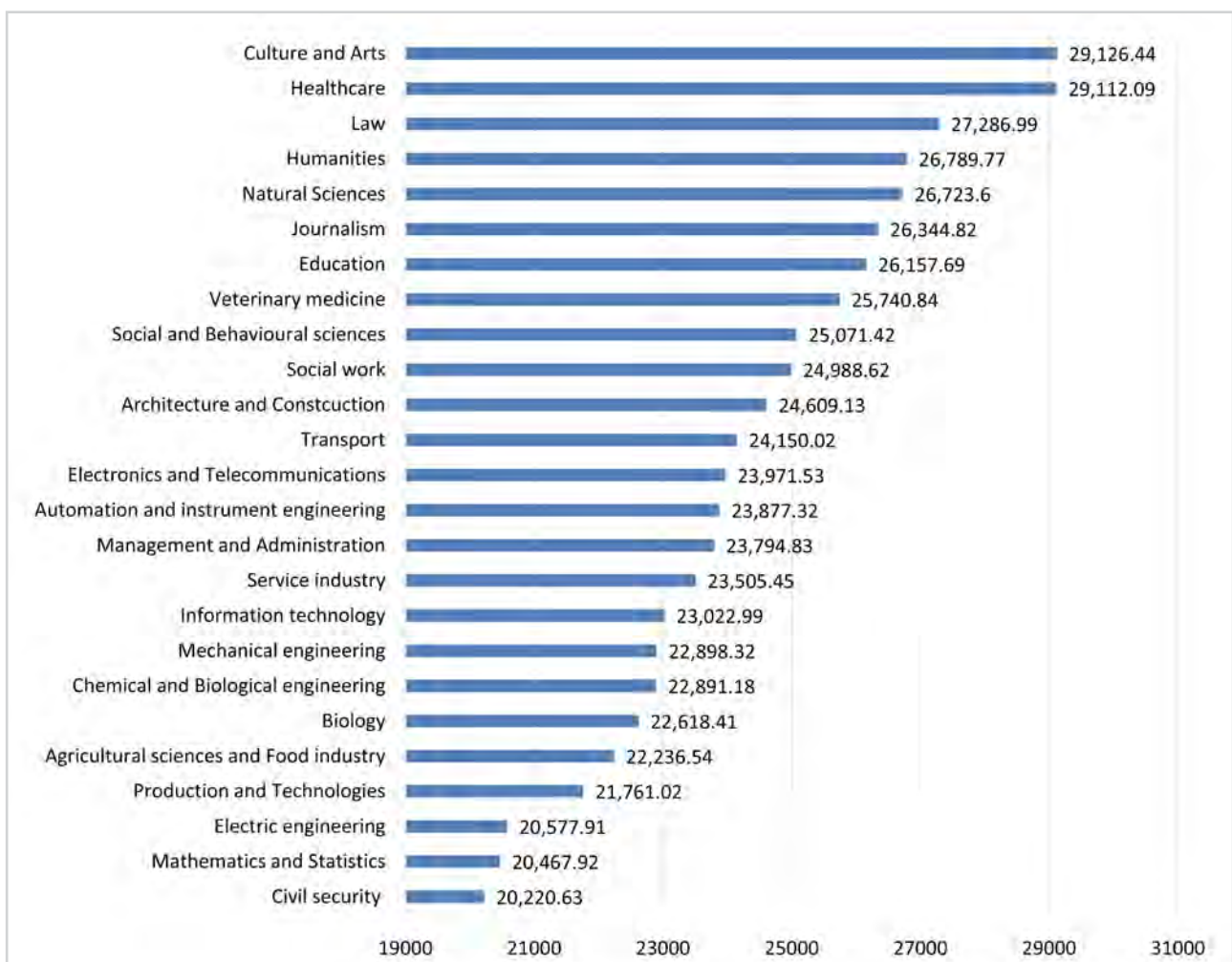


Figure 3:  
**The weighted average cost of training of the full-time bachelors under the governmental contract by knowledge areas in the 2015-2016 academic year**  
Source: Compiled by the authors based on [25]



We can note a similar pattern of results. The most valuable areas of knowledge remain Culture and Arts, Healthcare and Humanities. Technical knowledge area degrees are on the medium positions. The specialists with technical degree Architecture and Construction, Transport, Electronics and Telecommunications, and Automation and Instrument Engineering are highly demanded in the Ukrainian market. The cost of training high-tech professionals, in particular Mechanical Engineering, Chemical and Bioengineering, Electrical Engineering has increased relatively. They have been ranked higher than before.

As international experience shows, in order to make managerial decisions easier in practice, it is advisable to have comparative coefficients for several groups of knowledge areas. We carried out such a grouping exercise, drawing on the EU countries experience (Miroiu & Vlăsceanu, 2012; Pabian, Melichar, & Šebková, 2006) [13-14; 21; 37]. As a result of our research, six groups of comparative coefficients were formed:

- 1) Humanities, Social and Behavioural Sciences, Journalism, Management and Administration, Law, Social Work, Service Industry;
- 2) Information Technology (IT), Education, Mathematics and Statistics;
- 3) Mechanical Engineering, Electrical Engineering, Automation and Instrument Engineering, Electronics and Telecommunications, Production and Technologies, Transport, Architecture and Construction;
- 4) Chemical and Biological engineering, Agricultural Sciences and Food Industry, Biology, Natural Sciences;
- 5) Veterinary Medicine and Healthcare;
- 6) Culture and Arts.

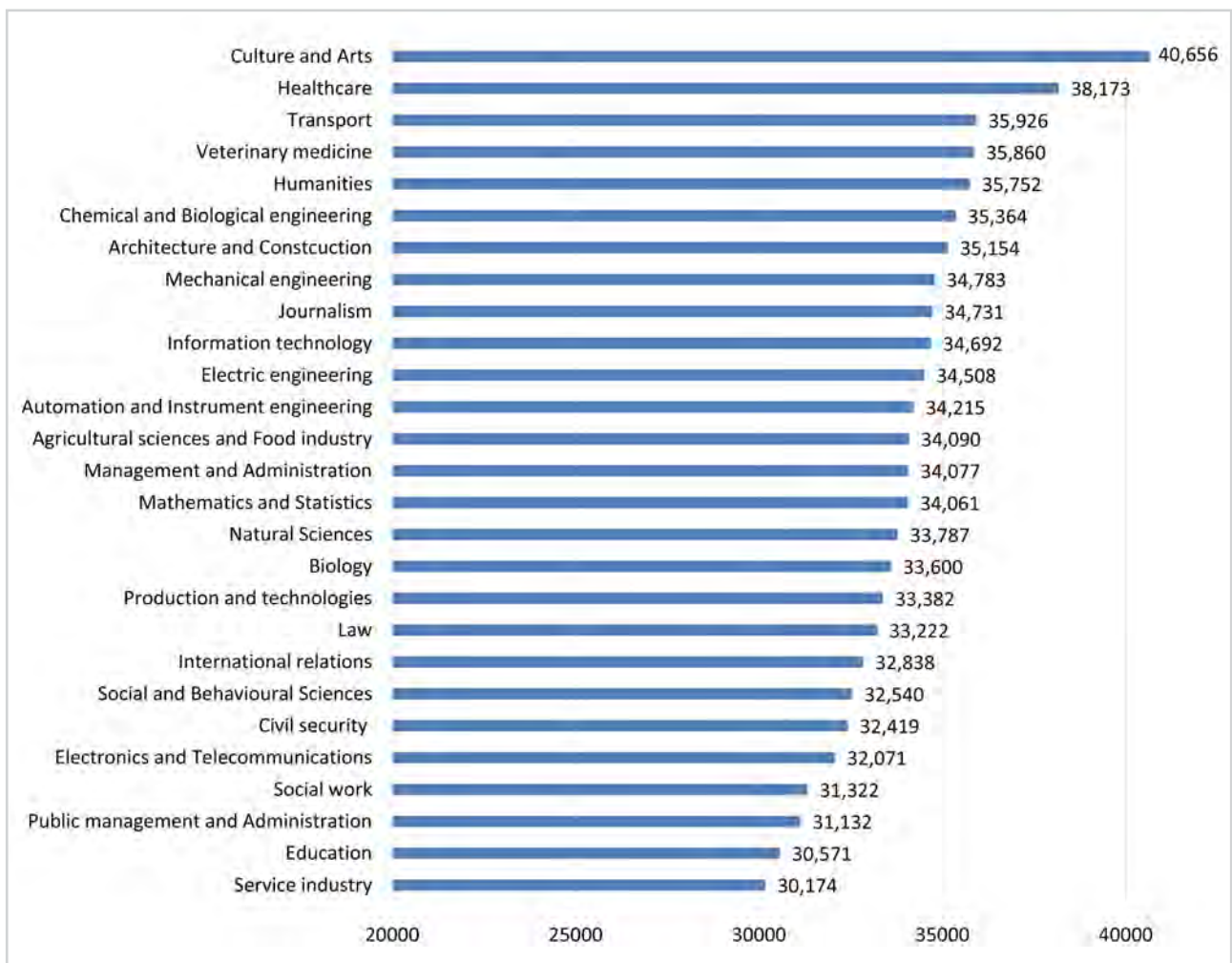


Figure 4:  
**The weighted average cost of training of the full-time bachelors under the governmental contract by knowledge areas in the 2017-2018 academic year**  
Source: Compiled by the authors



The weighted average cost of training the full-time bachelors under the governmental contracts for those 6 groups of knowledge areas in the 2015-2016 and 2017-2018 academic years is shown in Figure 5.

During 2015-2018 the cost of training specialists in all knowledge areas groups increased. However, the group structure of relative costs remained virtually unchanged. The cost of training bachelors in Groups 5 and 6 continues to dominate, while the costs of training Group 2 (Information Technology, Education) and Group 4 (Chemical and Bioengineering, Agricultural Sciences and Food Industry, Biology, Natural Sciences) were somewhat decreased. The cost of training a specialist in Group 1 (Humanities) remains rather high. It is almost the same as the cost of training a specialist in Group 3 (Engineering).

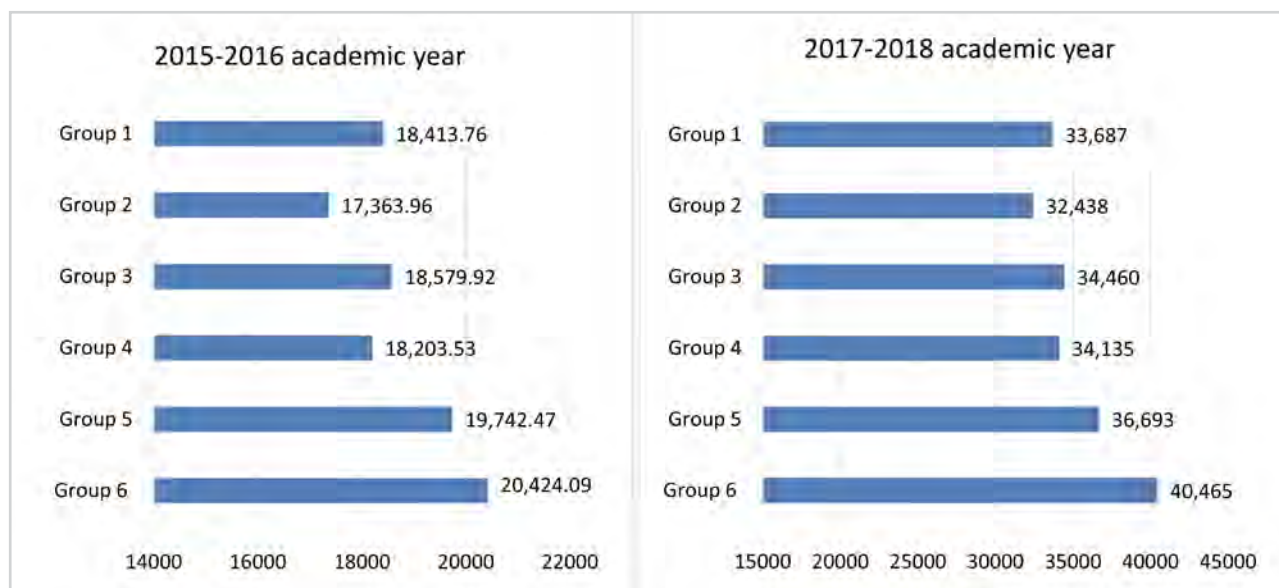


Figure 5:

The weighted average cost of training the full-time bachelors under the governmental contracts for 6 groups of knowledge areas in the 2015-2016 academic year (left) and the 2017-2018 academic year (right)

Source: Compiled by the authors

### 4.3. «Top-down» approach. Regression modelling

The «top-down» approach is based on the creation of a regression model applicable to the educational environment of higher education institutions in Ukraine.

The authors assume that the cost of educational services in a particular knowledge area depends linearly on the number of students:

$$C = f(N) = c_1 N. \tag{1}$$

This assumption is based on the following facts:

- a significant part of educational service is provided to students individually;
- the cost of group and course lectures is determined by a piecewise-stable function that can be approximated by a linear function for large volumes of students.

The system of equations for applicants of a specific educational and qualification level (e.g. Bachelor) who study in  $n$  higher education institutions of Ukraine in  $m$  knowledge areas of higher education can be presented as follows:

$$\begin{aligned} Y_1 &= \alpha_0 + \alpha_1 X_{1,1} + \alpha_2 X_{2,1} + \dots + \alpha_m X_{m,1}, \\ Y_2 &= \alpha_0 + \alpha_1 X_{1,2} + \alpha_2 X_{2,2} + \dots + \alpha_m X_{m,2}, \\ &\dots \dots \dots \\ Y_i &= \alpha_0 + \alpha_1 X_{1,i} + \alpha_2 X_{2,i} + \dots + \alpha_m X_{m,i}, \\ &\dots \dots \dots \\ Y_n &= \alpha_0 + \alpha_1 X_{1,n} + \alpha_2 X_{2,n} + \dots + \alpha_m X_{m,n}, \end{aligned} \tag{2}$$

where:

$Y_1, Y_2, \dots, Y_i, \dots, Y_n$  is the amount of funds spent on student training by the first, second, ...,  $i$ -th, ...,  $n$ -th higher education institution;

$X_{1,i}, X_{2,i}, \dots, X_{m,i}$  are the number of students of the respective specialty (study program) in the  $i$ -th higher education institution ( $i = 1, \dots, n$ );

$\alpha_1, \alpha_2, \dots, \alpha_m$  are the average cost (for the existing educational environment) of specialist training for the respective specialty (study program) under which the higher education recipients are trained.

Thus, the average cost of a specialist training will be defined as model parameters. The advantage of this approach is relatively simple information support and a model generalization made for the existing educational environment of the country. Estimates of the cost of training a specialist in the relevant study programs are average for the given educational environment and can be used, for example, in medium-term budget planning.

The amount of funds spent by HEIs on student training was taken from the information forms filled in by HEIs and the financial reports of HEIs submitted to the State Treasury Service of Ukraine. For modelling data in different years it was possible to use data from about 45 HEIs.

The following model was created on the basis of equation (2) and available data array:

$$Y = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \alpha_5 X_5 + \alpha_6 X_6, \quad (3)$$

where:

$Y$  is the scope of funds of general and special funds in the HEIs cost estimate;

$X_1, X_2, X_3, X_4, X_5, X_6$  are the number of students in the abovementioned groups of knowledge areas;  $\alpha_1, \alpha_2, \dots, \alpha_6$  are the cost of training one specialist for these groups, relative to the maximum value (the maximum value corresponded to the cost of training a specialist relevant to Group 6 «Culture and Arts»).

The simulation results for the 2015-2016 academic year can be described by the following equation:

$$Y = 0.45X_1 + 0.10X_2 + 0.37X_3 + 0.29X_4 + 0.69X_5 + 1.00X_6 + 19.60, \quad (4)$$

determination ratio is  $R^2 = 0.85$ .

An equation based on the information for the 2016-2017 academic year would look as follows:

$$Y = 0.45X_1 + 0.11X_2 + 0.41X_3 + 0.30X_4 + 0.80X_5 + 1.00X_6 + 46.57, \quad (5)$$

determination ratio is  $R^2 = 0.95$ .

A similar equation based on the information in the 2017-2018 academic year would look as follows:

$$Y = 0.40X_1 + 0.40X_2 + 0.60X_3 + 0.53X_4 + 0.75X_5 + 1.00X_6 - 248, \quad (6)$$

determination ratio is  $R^2 = 0.90$ .

The models were adequate and were monitored for heteroscedasticity, autocorrelation and multicollinearity. The latter were not found.

The simulation results in the framework of the «top-down» approach by which it is possible to evaluate the relative cost of training (the maximum value is 1.00) of a Bachelor degree specialist in Ukraine in the 2015-2017 academic years are presented in Table 1.

As we can see from Table 1, the highest value of the training costs is in Groups 5 and 6. It correlates with the results presented in Figure 5.

Among the other four groups, the cheapest (on average for 2015-2017) is the specialist training in Group 2 (IT, Education, Mathematics and Statistics). In general, the resulting simulation estimates are consistent with the results of the self-assessment of the HEIs. The simulation confirms that it is relatively expensive to train specialists in the first group in comparison to the other groups. In particular, in 2015-2016, the cost of training humanitarian specialists was higher than the training of specialists in engineering areas. The estimate for 2017 indicates a certain change in the trend,

Table 1:  
Relative values of the training cost (the maximum value is 1.00) of one Bachelor degree specialist in Ukraine in 2015-2017, obtained from the «top-down» simulation

Groups of specialties (study programs)	Relative units		
	2015/16 academic year	2016/17 academic year	2017/18 academic year
1	2	3	4
1. Humanities, Theology, Social and Behavioural sciences, Journalism, Management and Administration, Law, Social Work, Service Industry	0.45	0.45	0.40
2. IT, Education, Mathematics and Statistics	0.10	0.11	0.40
3. Mechanical Engineering, Electrical Engineering, Automation and Instrument Engineering, Electronics and Telecommunications, Production and Technologies, Transport, Architecture and Construction	0.37	0.41	0.60
4. Chemical and Biological Engineering, Agricultural Sciences and Food Industry, Biology, Natural Sciences	0.29	0.30	0.53
5. Veterinary Medicine, Healthcare	0.69	0.80	0.75
6. Culture and Arts	1.00	1.00	1.00

Source: Compiled by the authors

when the training cost for Engineering specialties prevails the training cost of the specialists from the first group.

The obtained result indicates a mismatch between the necessary costs for the training of specialists in Engineering specialties and lower cost of their training for budgetary funds than the humanities specialists. This result may be explained by the existing system of budgetary allocation between higher education institutions. As budgetary institutions, higher education institutions are guaranteed to receive funds for remuneration in accordance with the staffing lists approved by the Ministry of Education and Science of Ukraine. The amount of these funds is more than 80% of the total amount of financing of HEIs. The amount of remuneration depends on the share of scientific and pedagogical staff with scientific degrees (PhD and D.Sc.) and academic titles (Associate Professor, Professor). Therefore, the revealed relationships primarily reflect the difference in the share of scientific and pedagogical staff with relevant degrees and titles in the knowledge areas and do not take into account expenditures, in particular, on educational equipment for which the state has not allocated funds for many years.

## 5. Conclusions

1. Transformation of higher education in Ukraine is inevitable. This is due to the need for higher education institutions to survive in the competition with foreign universities, which attract Ukrainian students to study and reduce cash flows for educational services of domestic universities. On the other hand, the state will also reduce the budget support of Ukrainian universities due to the emergence of other priority problems (in particular in the field of military defence), which must be addressed urgently.
2. A promising direction in the reform of higher education may be the use of incentive progressive tools that can improve the quality of education while maintaining or even reducing the amount of funding, e.g. a performance-based funding (PBF). However, the use of the PBF in the allocation of budgetary resources requires a detailed study of the current state of public funding for higher education and determining of key economic indicators of the higher education sector, in particular cost evaluation of the educational services in training a specialist of certain specialty.
3. In order to more reliably determine the interrelation between the costs of training specialists in specific specialties, the article suggests a comparative method for the implementation of such an evaluation from two perspectives: the evaluation «from bottom» and the evaluation «from top». The «bottom-up» evaluation was carried out on the basis of the statistical processing of the HEIs self-assessment results according to the method by which they make calculations when preparing budget requests to the Ministry of Education and Science of Ukraine, when applying for budget financing. The «top-down» evaluation is based on the creation of a regression model applicable to the higher education institutions of Ukraine.
4. A linear regression model was created in which the budgetary funds for a single student education are compared with the number of students of various specialties in higher education. The relative average cost of specialist training is defined as the model parameters. The advantage

of this approach is relatively simple information support, a model generalization is made for the country's current educational environment, and the costs of a single specialist training for the corresponding knowledge areas are «averaged» for this educational environment and can be used, for example, in medium-term budget planning.

5. The obtained results indicate that the simulation estimates correspond to the results of the self-assessment of the HEIs: the cost of training humanities specialists is relatively expensive; also it is higher than the training of engineering specialists. In recent years, there has been a certain change in this trend, and the relative cost of engineering training is increasing.

Simulation and comparing the results obtained by different approaches, reveals certain details and allows us to understand the key problems of the ongoing financing of HEIs in Ukraine. The obtained result indicates an internal discrepancy of lower training costs for specialists of engineering specialties studying for budgetary funds in comparison with humanities specialists. This might be a direct consequence of the current procedures for the allocation of budgetary resources among HEIs: the amount of funding depends primarily on the proportion of teachers with Candidate of Science and Doctor of Science degrees, and is weakly dependent on the cost of training equipment, since for many years the state did not allocate funds for such equipment.

The introduction of new methods of allocating budgetary funds between higher education institutions should be gradual in order to avoid sharp fluctuations that may have negative social consequences. The resulting cost ratios for educational services by specialty groups can be used to plan a smooth transition to new economically sound distribution methods.

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