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ASSESSMENT OF THE EFFICIENCY OF BUDGETARY FUNDING OF GENERAL SECONDARY EDUCATION IN UKRAINE

ABSTRACT

The Ukrainian education system has demonstrated remarkable resilience, continuing to function even under the adverse circumstances of war. The government has introduced a wide range of measures to amend regulations and legislation, enabling educational institutions, teachers, and students to adapt to the conditions of martial law. New management, training, and budgetary tools have been implemented, which influence all aspects of the educational process due to their universality. The aim of this study is to develop new approaches to assessing the efficiency of budget funding for general secondary education at both the state and regional levels. Specifically, we explore the possibility of using the adapted method of Data envelopment analysis (DEA). We used this method to quantitatively assess the efficiency of budget funding during the pre-war period (2020-2021). For the war period (2022), we used statistical analysis due to significant changes in the information base. To assess the efficiency of budget financing of teachers' salaries in general secondary education institutions, we considered two input indicators: funds from the state educational subvention (transferred from the state budget to local budgets) and local budgets' own funds for education. Student's achievements in Ukrainian language and literature, history of Ukraine, mathematics, and English were used as performance indicators of the educational process in the national external independent evaluation of 2020-2021 in the regional context. A "thermal matrix" was created to display integral indicators of the efficiency of regional budget financing. This tool is used for risk-based management and helps to identify problems in education, enabling regional managers to formulate more effective education policies. In summary, the effectiveness of the adapted DEA method for assessing the efficiency of budget financing for general secondary education has been confirmed. The specific challenges of implementing the DEA method during the period of martial law will be the subject of our further research.

Keywords: efficiency of budget financing, DEA method, general secondary education, thermal matrix of financing efficiency indicators, cost and performance indicators of the educational process

JEL Classification: H52, I22, I28

INTRODUCTION

The global economy is undergoing rapid transformations due to technological advancements, globalization, and a shift towards knowledge-based industries. As a result, the significance of human capital has grown, emphasising the crucial role played by individuals' knowledge, skills, and competencies in driving economic prosperity. For example, developed countries have recognized that over half of their GDP is derived from the intellectual capabilities of their citizens.

Therefore, human capital is increasingly important in modern national economies' models, which focus on actively using new technologies and innovations. The concept of "human capital" has evolved from its earlier, primarily physical interpretation (Samuelson, 2005), to a broader understanding that highlights the significance of an individual's intellectual assets. This evolution has occurred alongside the development of economic growth theories that emphasise how people become more productive and develop new

technological processes through education and the skills acquired during learning (Barro, 1996; Faggian et al., 2019).

The Organisation for Economic Cooperation and Development (OECD, 2001) provides a widely accepted definition of human capital, describing it as "the knowledge, skills, competencies, and attributes embodied in individuals that facilitate the creation of personal, social, and economic well-being". Health and education are critical components of human capital that are important for the labour market (Florida, 2002, 2005; Okafor et al., 2017). Therefore, researchers often stress the significance of societal investment in education as it promotes sustainable economic development, sustains cultural interaction and facilitates the transfer of experience across generations (Lee et al., 2007; Patel et al., 2019).

LITERATURE REVIEW

In most countries, the general secondary education system is a fundamental aspect of citizens' education, covering the longest educational period, usually lasting from 6 to 18 years. Its purpose is to provide individuals with a broad base of knowledge inherited from previous generations, to promote essential socialization skills, and to shape a student's personality to become a successful member of society. Primary and basic education is mandatory in many countries, including the European Union, and is funded by the state budget as part of general secondary education. It is crucial to ensure effective budget funding in this regard, as governments aim to achieve the best educational results with reasonable budgetary expenditures. At the same time, it is necessary to achieve efficiency in budget funding, taking into account the diversity of schools in terms of their size, teaching staff, as well as other educational and social characteristics. For example, small schools in rural areas, particularly in villages, typically serve as not only educational centres but also cultural hubs. Therefore, closing such schools may cause young people to leave, resulting in the decline of rural regions (Londar, 2019).

A number of approaches exist in which researchers use quantitative methods to determine the effectiveness of budgetary spending on education. These methods involve analyzing the relationship between educational outcomes and the level of funding provided. This, in turn, provides a foundation for management decisions aimed at improving efficiency. For instance, Kovtunets and Londar (2019), proposed a method for evaluating the efficiency of budgetary provision for Ukrainian universities. The comparison of the "bottom-up" and "top-down" techniques revealed an uneven distribution of funds among various specialisations in specialist training, indicating the inefficacy of fund allocation.

According to Herczyński's (2011) research, funding for general secondary education in Macedonia is insufficient when compared to OECD countries. The study proposes indicators and strategies to enhance the efficiency of education funding.

Alonso and Sanchez (2011) analyzed budgetary efficiency for general secondary education in transition economy countries, using its indicators and comparing them with the average indicators of selected countries. In 2019, the World Bank conducted a study (World Bank, 2019) on the funding allocation formula for general secondary education in Ukraine, including modifications made since 2015.

To evaluate the effectiveness of managing secondary education at the local community level, various methods can be used. One such method is Data Envelopment Analysis (DEA), which was first proposed by A. Charnes, W. Cooper, and E. Rhodes (1978). DEA has primarily been used to evaluate the efficiency of programs run by nonprofit organizations that receive public funding. Since then, the DEA method has evolved and is now applied to various other situations where there are multiple factors characterizing costs (inputs) that can be managed, as well as various performance indicators (outputs) that are indicators of management effectiveness (Lin and Zhao, 2022). However, some researchers have pointed out specific limitations of the CCR models used in the DEA approach and have recommended methods for their joint application with other models (Dellnitz et al., 2018).

Londar et al. (2022) considered the possibility of using one of the modified DEA methods to evaluate the efficiency of budgetary funding for general secondary education. For this purpose, the authors analyzed the funding of schools in the Zaporizhzhya region of Ukraine in 2020 using the state budget's educational subvention. The performance indicators of the model were calculated based on the results of a nationwide external independent evaluation (EIE) in several subjects, in which students were tested when graduating from school. The authors proposed various performance indicators and calculated the corresponding integral efficiency indicator. The article emphasised the potential of using the modified DEA method to address governance concerns related to consolidating the network of secondary education institutions.

AIMS AND OBJECTIVES

The aim of this study is to develop new approaches for assessing the efficiency of budget expenditures for general secondary education at both the central and local levels. The study specifically aims to investigate the potential use of the

Data envelopment analysis (DEA) method adapted for application in the field of education. A quantitative evaluation of budget efficiency was conducted using the DEA method for the pre-war period of 2020-2021. During the war period of 2022, significant changes occurred in the functioning of the education sector. Therefore, only statistical analysis was used to study this period. A "thermal" matrix was created to display the integral indicators of budget funding efficiency by region. This is a management tool that can help identify issues with budget funding and improve the planning of measures to prevent negative phenomena. It also enables regional managers to form a more effective educational policy.

METHODS

As mentioned, the main purpose of this study was to investigate the possibility of assessing the effectiveness of budget financing of general secondary education, in particular, using the adapted DEA method Londar et al. (2022) and to develop on this basis a risk-based tool useful for decision-making in education management. The data were collected in accordance with the research objective. Official reports from the State Treasury Service of Ukraine were used to create a dataset on expenditures within the application of the DEA method. These reports contained information on the amount of educational subventions allocated to each community in 25 Ukrainian regions for teacher salaries during 2020-2021. The required indicators were calculated using aggregated administrative and statistical information from the Ukrainian Automated Information Complex of Educational Management (AICEM) database (Verkhovna Rada of Ukraine, 2022; Ministry of Education and Science of Ukraine, 2022). The AICEM database collects individual information about students and teachers, starting from the level of each school, according to official statistical forms. Further, the information is aggregated at local, regional, and national levels and made available to users in their preferred format.

As performance indicators, the results of the annual nationwide EIE results were used. The EIE was introduced in Ukraine in 2008 as a standardized testing method for school graduates during their state final attestation and admission to higher education institutions (HEIs). It should be noted that the evaluation is conducted on a national scale with a standardized methodology, ensuring that all participants are given the same rules, test structure, and test set. The implementation of the EIE in Ukraine, which was supported by international organizations, contributed to the improvement of the quality of secondary and higher education. It has also become a crucial factor in ensuring equal access to higher education and overcoming corruption during admission to HEIs. The examination results are publicly accessible on the Ukrainian Center for the Evaluation of the Quality of Education website (UCEQE, 2023). The corresponding reports provide comprehensive depersonalized data on the results of all participants, as well as generalized data for educational institutions, districts, cities, and regions throughout Ukraine. It is important to note that the generalized data for districts and regions are more resistant to the influence of factors that can distort the values of indicators for schools (i.e., influence of tutors, parents, etc.). Therefore, we used the EIE results achieved by graduates from different regions as performance indicators in our model.

The statistical and administrative data aggregated in this way enable the study of the application of the adapted DEA method for evaluating the efficiency of budget funding in schools and comparing it across Ukrainian regions. To better illustrate the obtained results, a risk-oriented approach was used with thermal matrix visualization (Rogova and Londar, 2021; Shkarlet et. al., 2021). This visualization assists educational managers in making sound decisions when formulating educational policies for future periods.

RESULTS

Table 1 presents the key indicators of the development of general secondary education in Ukraine during the pre-war period of 2020-2021. The total number of general secondary education institutions during this period decreased due to consolidation processes (creation of so-called supporting schools with branches) while simultaneously increasing the number of students. The number of students per teacher increased from 9.3 in 2020 to 9.5 in 2021. Consolidation of schools has the potential to improve the quality of education by concentrating resources. However, sometimes it can also lead to a decline in access to education, particularly in rural areas where "small" schools may be closed. The decrease in the number of teachers is mainly due to their retirements. Capable local budgets have also contributed to financing general secondary education. In 2020, the sum of UAH 4.238 billion was allocated for this purpose, and in 2021, this amount increased to UAH 4.974 billion.

Table 1. The main indicators of the development of general secondary education in Ukraine in 2020-2021. (Source: calculated by the authors based on the data from the State Treasury Service of Ukraine and the Ukrainian Center for the Evaluation of the Quality of Education)

Indicator	Indicator value							
	2020	2021						
The total number of institutions of general secondary education, <i>units</i>	14 815	13 991						
Total number of classes, <i>units</i>	208 689	208 342						
The total number of students, <i>persons</i>	4 191 538	4 230 358						
The total number of pedagogical staff, <i>persons</i>	449 965	445 367						
The carry-over educational subvention funds on January 1, <i>UAH billion</i>	5.257	5.323						
The received educational subvention funds, <i>UAH billion</i>	81.224	100.135						
The used educational subvention funds (cash expenses), of which:	81.158	99.8						
the expenses for the salary of pedagogical staff in communal institutions of general secondary education, <i>UAH billion</i>	73.406	92.539						
the expenses for the salary of pedagogical staff in vocational education institutions, vocational pre-higher education institutions, etc., <i>UAH billion</i>	7.752	7.261						
The carry-over educational subvention funds on December 31, <i>UAH billion</i>	5.323	5.657						
The expenses for the salary of pedagogical staff in communal institutions of general secondary education from the funds of local budgets, <i>UAH billion</i>	4.238	4.974						
The number of rates of pedagogical staff in communal institutions of general secondary education, <i>units</i> <i>among them:</i>	502 890	542 773						
<i>the number of rates of teaching staff, units</i>	416 694	437 122						
<i>the number of rates of teaching staff not involved in teaching lessons, units</i>	86 196	105 651						
The average salary for one rate of a pedagogical staff from the funds of the educational subvention, <i>UAH</i>	12 164	14 208						
The average salary for one rate of a pedagogical staff from the funds of the educational subvention and local budgets, <i>UAH</i>	12 855	14 972						
Average expenditures per student from educational subvention funds, <i>UAH</i>	17 950	22 295						
Average expenses per class from educational subvention funds, <i>UAH</i>	361 241	445 177						
Average number of classes, <i>persons</i>	19.8	20						
EIE results	Ukrainian language and literature		History of Ukraine		Mathematics		English	
	2020	2021	2020	2021	2020	2021	2020	2021
Took part in the EIE, <i>persons</i>	188 497	153 667	124 501	129 589	108 021	163 442	84 815	98 020
Overcame the "passed/failed" threshold, <i>persons</i>	177 369	145 006	110 336	110 308	98 088	122 963	79 880	90 265
% of all participants	94.1	94.4	88.6	85.1	90.8	75.2	94.2	92.1
Received 180 points and more, <i>persons</i>	31 252	24 542	7 850	10 030	11 556	14 426	14 116	18 228
% of all participants	16.6	16.0	6.3	7.7	10.7	8.8	16.6	18.6
The average score among those who overcame the "passed/failed" threshold, <i>points</i>	149.8	148.8	137.6	140.2	143.2	142.5	150.1	150.7

Improving the quality of education requires budget funding and creating conditions for teachers to receive decent salaries. As stated by Schleicher (2018), the founder of the PISA International Educational Assessment, "the quality of an education system can never exceed the quality of its teachers".

However, it is unclear from Table 1, in the part that shows the results of the EIE testing of school graduates in Ukraine, whether the increase in funding for teachers' salaries gives the expected result. In particular, the data shows that a similar percentage of EIE participants passed the threshold in Ukrainian language and literature in both 2020 and 2021 (94.1% and 94.4% respectively). However, there was a slight difference in the subjects of history of Ukraine (88.6% and 85.1%) and English (94.2% and 92.1%). In mathematics, however, these figures were 90.8% and 75.2%, indicating a significant difference of – 15.6%. It is also noteworthy that the proportion of school graduates who scored 180 or more points in mathematics decreased from 10.7% to 8.8%, that is, by almost 2%. This data may be influenced by various factors, such as different levels of test difficulty, choice of the "passed/failed" threshold value, system inertia, and insufficient salary

growth compared to average indicators in the economy as a whole. Therefore, further study is required to investigate these factors.

To achieve a more objective evaluation of budget funding efficiency, it is necessary to employ quantitative analysis methods.

Figure 1 shows the average number of classes and the average actual costs per student in different regions of Ukraine, funded by educational subvention and local budgets for 2021.

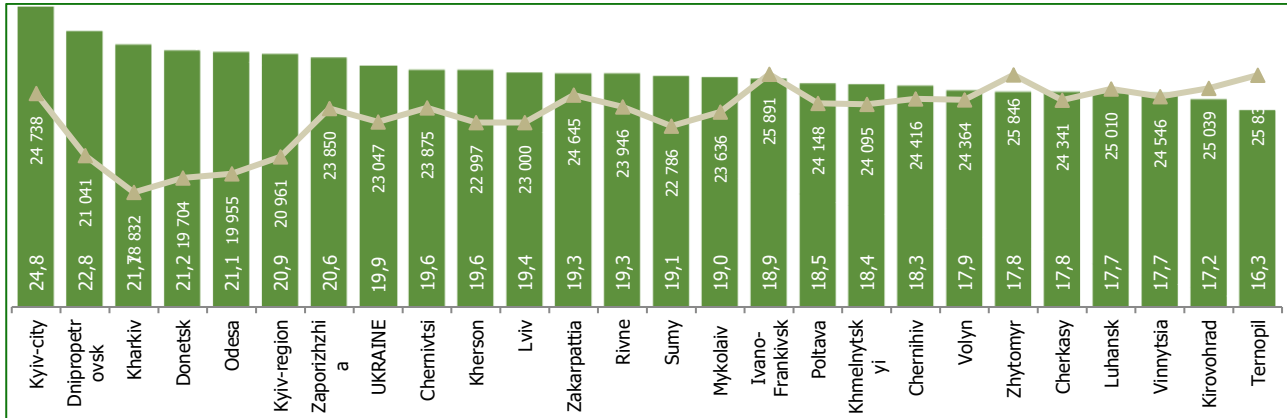


Figure 1. Average class size and average actual costs per student (from educational subvention funds and own funds of local budgets) by regions of Ukraine in 2021, persons, UAH. (Source: calculated and compiled by the authors)

Kyiv is notable for providing significant additional funding from the local budget for teachers' salaries. This has resulted in an increase in the average teacher's salary from UAH 17,207 to UAH 24,738, which is almost a 44% rise compared to what it would have been without the additional funding from local funds. In general, there is a significant negative correlation (the correlation coefficient is -0.85) between the average class size and the average actual costs per student in the regions, except for Kyiv. This means that the higher (within the permissible range) the number of students in the class is, the cheaper it is for the budget to train one student. Since the increase in the number of classes was stimulated by measures to consolidate schools, we can say that they led to a reduction in the cost of training one student at the expense of the budget. However, consolidation alone is insufficient to improve the quality of education. Accompanying measures should be implemented to enhance the quality of education. Therefore, on the basis of the above estimates, it is worth drawing a conclusion not about the reduction of expenses for general secondary education, but about the possibility of increasing the financing of both salaries and material, technical and other support of the educational process thanks to the freed funds.

Figure 2 compares the value of the average monthly salary of pedagogical workers, financed from the funds of the educational subvention and own funds of local budgets, with the average score of school graduates' EIE in 2021 by region of Ukraine.

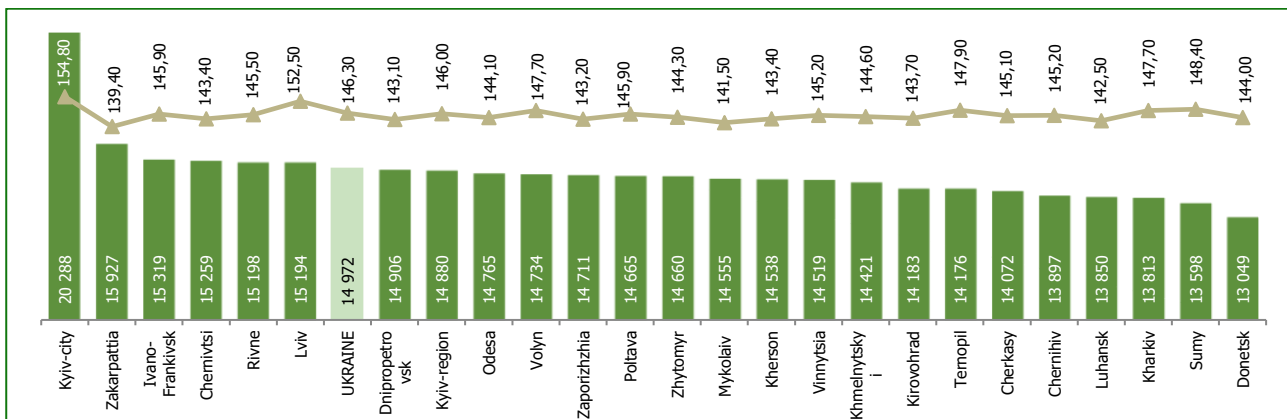


Figure 2. Average monthly salary (with accruals) of teaching staff, funded by the educational subvention and local budgets, and the average EIE score (for all subjects) of school graduates by regions of Ukraine in 2021, UAH, points. (Source: calculated compiled by the authors)

The correlation between budget funding and the results of school graduates who took the EIE for admission to Ukrainian universities cannot be conclusively determined based on the data presented in Figure 2. To investigate this further, additional information will be taken into account, including the percentage of graduates who took the EIE and successfully passed the threshold, as well as the proportion of those graduates who achieved high scores.

To assess the efficiency of educational activities, we have applied the DEA method (Cooper et al., 2011; Sreedevi, 2016; Lin and Zhao, 2021). In our study (Londar et al., 2022), the DEA method was adapted for the first time to analyze the efficiency of budget funding for teachers' salaries in general secondary education institutions. We focused on secondary schools in the local communities of the Zaporizhzhya region of Ukraine, without considering non-educational results. The normalized average expenditures from educational subvention per student and per school class in general secondary education institutions founded by local communities were taken as indicators of funding. Weighting coefficients for both classes and students were taken equal to 1/2. As indicators of the efficiency of the educational process, we took the EIE results of school graduates of certain communities upon admission to HEIs.

Following (Londar et al., 2022), the integral efficiency indicator can be presented as:

$$E = \frac{\sum_{i=1}^m \alpha_i x_i}{\sum_{j=1}^n \beta_j y_j} \quad (1)$$

where x_i – performance indicators, y_j – cost indicators, α_i, β_j – corresponding weighting coefficients for indicators, n, m – number of relevant indicators.

In this study, cost indicators were calculated on the basis of data on the funding of teachers' salaries in general secondary education institutions by region. The funding consists of two components: the funds of the educational subvention, which is a transfer from the state budget to local budgets to finance the salaries of teachers in general secondary education, and local budget funds allocated for this purpose. The relevant data was collected from graduates' results in the EIE (UCEQE, 2023). In addition, data on the number of classes and students were obtained from statistical reporting forms on the activities of general secondary education institutions for the relevant years (SSI "IEA", 2023).

As separate indicators, the average funding per class and per student for each region were taken. To ensure comparability between the ranges of variation for both indicators, we normalized the values using the following transformation:

$$y_{j2}^* = y_{j2} \frac{\bar{y}_1}{\bar{y}_2} \quad (2)$$

where the normalized value of the amount of funding per class for j region y_{j2}^* was calculated based on the absolute value of this indicator for the corresponding region y_{j2} , which was multiplied by the average value of funding per student in Ukraine \bar{y}_1 and was divided by the average value of the amount of funding for one class in Ukraine \bar{y}_2 . The integral indicator of funding was calculated as the half sum of the amount of funding per student and the normalized amount of funding per class.

In the study, we also tested the hypothesis about the impact on the results of EIE of a certain year, not only the funding of the same year but also the funding of the previous year. This may be due to the fact that the terms of the budget year and the academic school year do not coincide, and school graduates take the EIE tests in the summer when the funding for the current year is only partially realized. To estimate this circumstance, the basic indicators were calculated by dividing the total funding for two years by the corresponding numbers of students and classes.

Figure 3 illustrates the relationship between the values of the integral indicator of one-year budget funding, calculated based on the data of 2020 and 2021, and the integral indicator of two-year funding in 2019-2020 and 2020-2021, respectively. This relationship can be approximated by linear functions $y = 0.6081x + 6768.7$ and $y = 0.7522x + 5578.1$. The coefficients of determination for these functions are $R^2=0.30$ and $R^2=0.38$, respectively. This indicates a moderate correlation, but also a significant variable part caused by other factors that can affect the amount of budget funding, the number of classes and students.

When calculating the efficiency of budgetary funding for education, we used one- and two-year data.

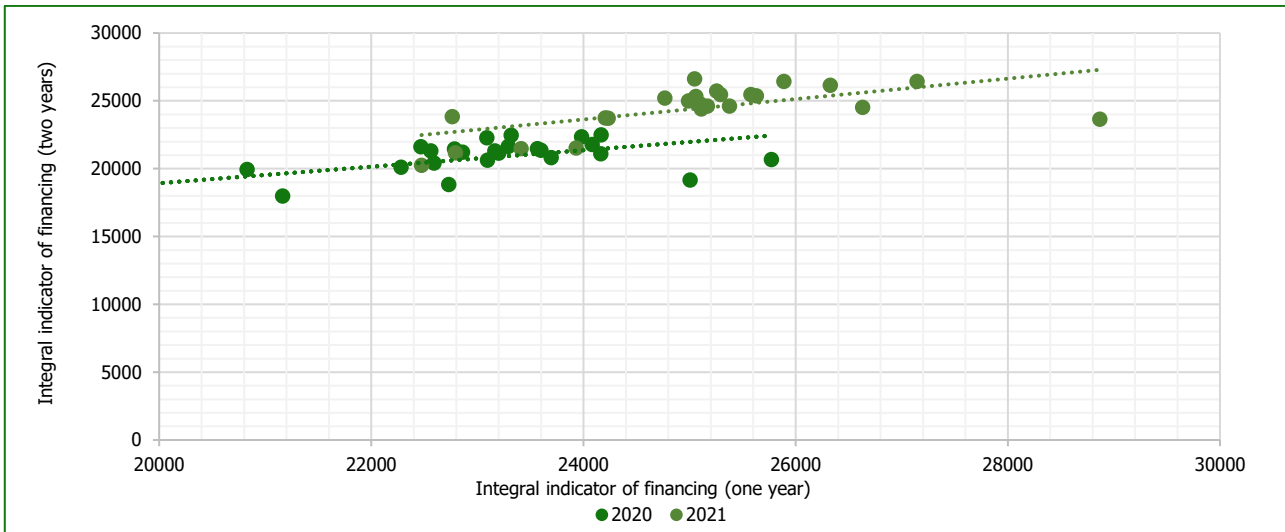


Figure 3. The relationship between the values of the integral indicators of one-year and two-year budgetary educational funding, relative units. (Source: calculated compiled by the authors)

In the context of applying the DEA method, we used the results of the EIE in Ukrainian language and literature, history of Ukraine, mathematics, and English as performance indicators of general secondary education institutions' activity by region. The relevant data was obtained from the official website of UCEQE (<https://zno.testportal.com.ua/opendata>). The indicator of the efficiency of the educational activity in the region for each subject was calculated as the arithmetic average for this subject of the percentage of graduates who passed the pass/fail threshold and the percentage of those who received 180 or more points. The specified percentages were taken from the total number of school graduates who took the relevant tests. The integrated performance indicator for the region was calculated as a weighted sum of performance indicators for individual subjects. At the same time, all tests were considered equally important and given a weighting factor of 1/4, in accordance with state standard requirements.

Further, efficiency indicators of budget funding for general secondary education by region were calculated using formula (1) and the approaches described above to determine integral indicators of costs and performance. The distribution of these indicator values by regions of Ukraine for 2021 is shown in Figure 4, which was calculated using one- and two-year budgetary funding.

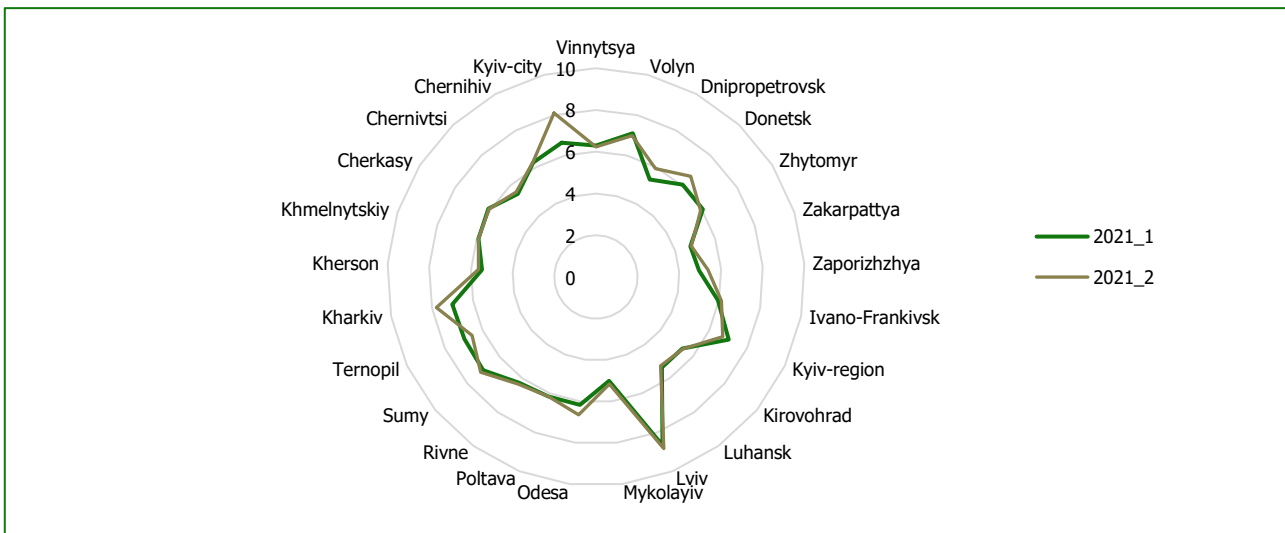


Figure 4. Regional distribution of the efficiency of the budget funding for general secondary education in 2021 (curves 1 and 2 correspond to the consideration of one-year and two-year funding, relative units).

As can be seen from Figure 4, the use of data on one- and two-year budget financing of education practically doesn't change the shape of the diagram of the regional distribution of budget financing efficiency. Kyiv, Lviv, and Kharkiv are the

regional leaders in achieving higher efficiency of budget financing for general secondary education compared to other cities.

Similar calculations were also carried out to determine the efficiency of budget funding for teaching individual subjects. The data used for this analysis (Gapon et. al., 2023) included the number of teachers in each subject by region. It was assumed that the proportion of the total salary fund with accruals allocated to the payment of these teachers was equal to their proportion among all teachers in general secondary education institutions. This assumption is supported by the fact that differences in the distribution of teachers by categories and pedagogical ranks within schools and communities at the regional level are levelled out due to sufficiently large sample sizes (ranging from 300 to over 3300 subject teachers per region). The calculation only considers the results of the EIE in the relevant subject.

Table 2 illustrates a thermal matrix of the results of the calculations, indicating the relative efficiency of budget funding for general secondary education across different regions of Ukraine for the teaching of individual subjects. The analysis considers the budgetary funding for 2020-2021 and the results of the EIE in 2021. To ensure comparability, the efficiency for each subject in which graduates were tested at EIE is presented as a fraction of its maximum value for that subject. The efficiency values of each subject were ranked from smallest to largest. From all 25 regions, seven with the worst results (indicated in red colour) and seven with the best results (indicated in green colour) were selected. Regions with average results are represented in yellow.

Table 2. Thermal matrix of the relative efficiency of using budget funds by regions of Ukraine for teaching certain subjects for which school graduates were tested within the EIE in 2021. (Source: calculated and compiled by the authors)

Regions	Ukrainian language and literature	History of Ukraine	Mathematics	English
Vinnitsia	0,721	0,491	0,495	0,637
Volyn	0,805	0,549	0,542	0,771
Dnipropetrovsk	0,688	0,559	0,612	0,731
Donetsk	0,722	0,581	0,596	0,698
Zhytomyr	0,653	0,441	0,430	0,664
Zakarpattia	0,515	0,412	0,384	0,760
Zaporizhzhia	0,634	0,491	0,539	0,641
Ivano-Frankivsk	0,704	0,575	0,504	0,833
Kyiv-region	0,775	0,577	0,527	0,598
Kirovohrad	0,625	0,436	0,421	0,691
Luhansk	0,559	0,430	0,409	0,618
Lviv	1,000	0,924	0,680	0,819
Mykolaiv	0,591	0,385	0,441	0,666
Odesa	0,734	0,559	0,597	0,792
Poltava	0,705	0,494	0,523	0,719
Rivne	0,711	0,549	0,545	0,812
Sumy	0,805	0,625	0,632	0,677
Ternopil	0,759	0,609	0,479	0,788
Kharkiv	0,889	0,695	0,786	0,865
Kherson	0,654	0,490	0,580	0,656
Khmelnyskyi	0,646	0,495	0,465	0,699
Cherkasy	0,691	0,492	0,499	0,651
Chernivtsi	0,634	0,574	0,455	1,000
Chernihiv	0,699	0,462	0,522	0,709
Kyiv-city	0,965	1,000	1,000	0,684

There is a significant difference in minimum results between subjects. Some values, which correspond to the lowest for Ukrainian language and literature and English would be in the best group for mathematics and history of Ukraine. There are no regions with an efficiency index below 0.6 for the English test, but there are 3 regions with such a low index for the Ukrainian language and literature test, and 19 and 20 regions for the mathematics and history of Ukraine tests, respectively.

This matrix can be used as a management tool by state authorities to assess the performance of the education sector at the regional level. For example, it shows that the regions of Zhytomyr, Zakarpattia, Kirovohrad, Mykolaiv and Luhansk have lower rankings than other regions. In contrast, the Kyiv city, Kharkiv, Ternopil, Sumy and Lviv regions have higher

efficiency in budget spending than others. In particular, the Kharkiv region stands out as having the highest efficiency, being in the upper (green) part of the rating for four subjects.

After Russia's full-scale invasion of Ukraine in 2022, there were significant changes in the funding of general secondary education. Specifically, as stated in the Law of Ukraine "On the state budget of Ukraine for 2022", which was adopted at the end of 2021, UAH 108.044 billion was earmarked for the educational subvention to finance teachers' salaries. Following the full-scale invasion, the Ukrainian government took into account new realities and the amount of educational subvention was reduced to UAH 97.239 billion.

Figure 5 displays the regional distribution of educational subvention funds allocated for teacher salaries in 2022.

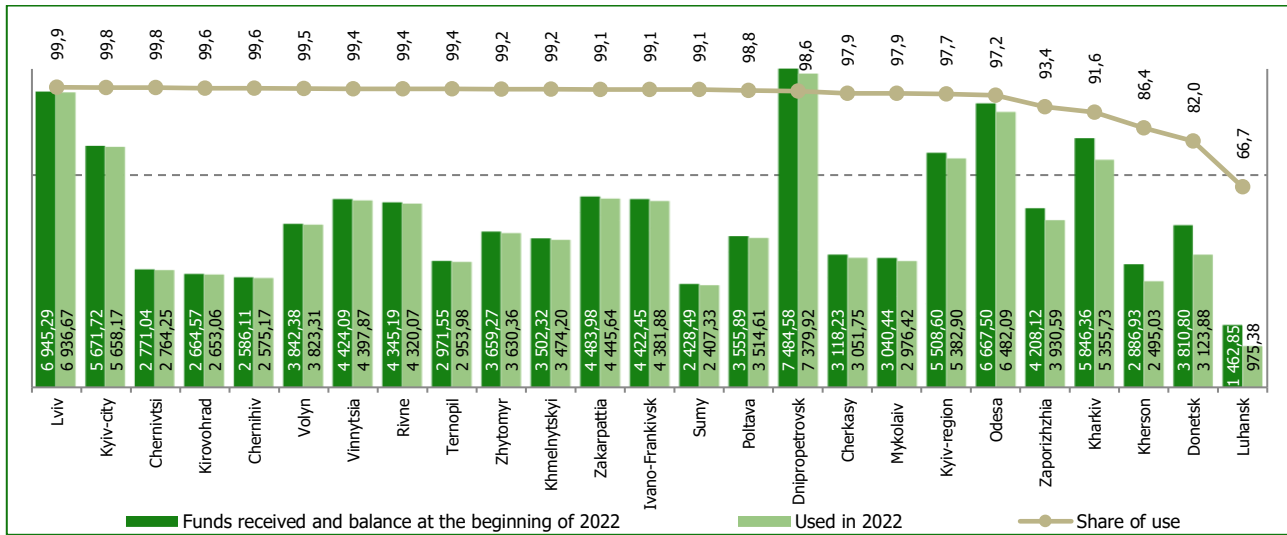


Figure 5. Use of educational subvention for the payment of teaching staff by regions of Ukraine in 2022, UAH million, %. (Source: calculated and compiled by the authors)

According to Figure 6, the regions that were experiencing active hostilities faced significant challenges in using the funds. In particular, schools in the Luhansk (66.7%) and Donetsk (82.0%) regions had the lowest indicators for the use of allocated budget funds. The mass migration of students, their parents and teachers to other cities and regions of Ukraine, as well as abroad, led to problems such as a lack of properly prepared payment documents, timely information about teachers' work and uncertainty about their status, etc. Similar problems, although to a lesser extent than in the mentioned Donetsk and Luhansk regions, were also observed in schools in the Kherson, Kharkiv and Zaporizhzhya regions.

As a result of these processes, significant balances of budget funds allocated to education have been created. Despite a 10% reduction in the planned number of educational subventions for 2022, as of 1 January 2023, there were UAH 3.219 billion in remaining funds for educational subventions totalling UAH 3.219 billion. In particular, of the total remaining funds for educational subventions, UAH 2.334 billion (72.4%) were concentrated in regions affected by hostilities and temporarily occupied territories.

We estimated the average monthly salary level of teachers (with accruals) in 2022 based on the type of educational institution providing general secondary education services. The results indicate the following salary distribution: in general secondary education institutions – UAH 15.327; in special general secondary education institutions where students need correction of physical and mental development – UAH 16.434; in specialized institutions – UAH 16.037; in institutions for orphans and children deprived of parental care, orphanages – UAH 15.408; in educational and rehabilitation centres for children with special educational needs – UAH 16.151; in vocational education institutions of ISCED-3.4 for teachers who teach in full secondary education programmes – UAH 16.312; in vocational education institutions of ISCED-5 – UAH 18.887; in inclusive resource centres – UAH 18.152.

Figure 6 shows the ratio of the average monthly salary (with accruals) of teaching staff (financed from educational subvention funds and own funds of local budgets) by region to the average score of school graduates in each region on the national multi-subject test (NMT) in 2022.

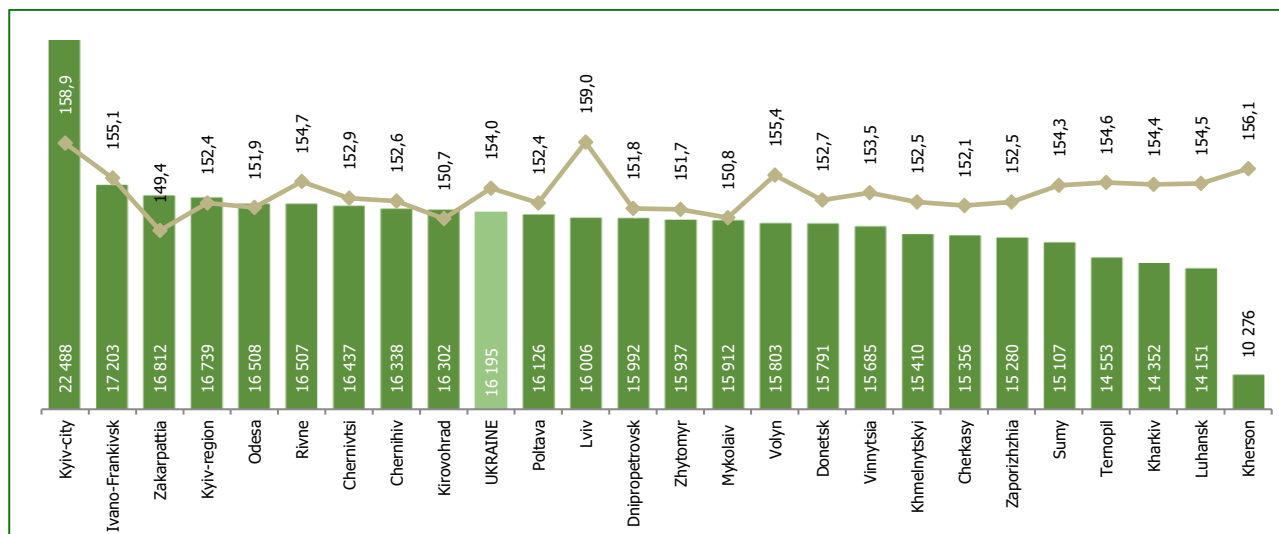


Figure 6. Average monthly salary (with accruals) of teaching staff (from educational subvention funds and own funds of local budgets) and average NMT score by regions in 2022, UAH, points. (Source: calculated and compiled by the authors)

As before, the data presented in Figure 7 do not provide sufficient evidence to make a clear statement about the influence of budget funding on the results of school graduates who have taken the NMT to enter Ukrainian universities. It is important to note that no pass/fail threshold was established for the NMT in 2022. Furthermore, the NMT was often administered in regions that differed from those where students had previously studied due to the full-scale military invasion. Some students took the exam in cities and towns with frequent and prolonged alarms, while others were far from home or even abroad and had to travel long distances to reach the testing centres. Thus, to estimate the efficiency of budgetary funding for educational activities using the DEA method, a significant revision of cost and performance indicators is necessary.

Figure 8 compares the average number of classes and the average actual budget expenditures per student in 2022 across the regions of Ukraine, funded by the educational subvention and local budgets' own funds.

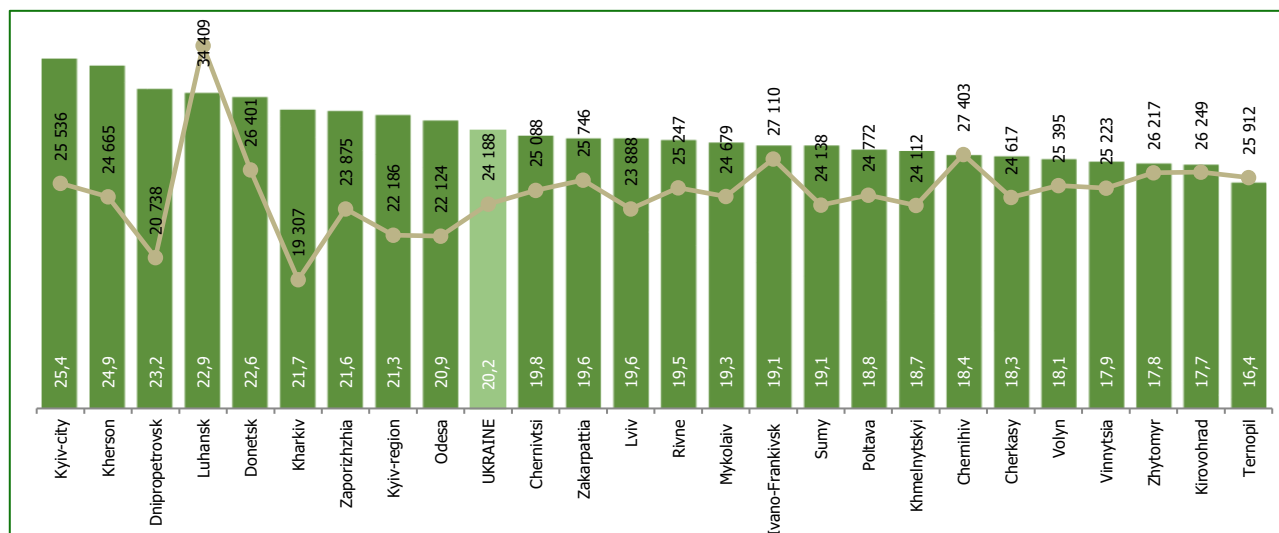


Figure 8. Average class size and average actual expenditures per student (from educational subvention funds and own funds of local budgets) by region in 2022, persons, UAH. (Source: calculated and compiled by the authors)

The indicator values are significantly high in the regions of Luhansk and Donetsk, where the most intense hostilities are taking place (see Figure 8). In contrast, schools in Kyiv city have traditionally received more substantial additional payments from the local budget compared to other regions. In general, except for these regions, there is a negative correlation between the average class size and the average actual budget expenditure per student in the regions. The correlation coefficient calculations show that the coefficient value for 2022 is -0.62 when the indicators of the specified regions are excluded. This suggests a significant inverse relationship between these indicators, confirming the previously stated thesis that a larger class size (within the acceptable range) reduces the cost of training per student for the budget.

DISCUSSION

Developing human capital is a vital task for any society, as its successful completion allows it to look towards the future with optimism. Developed countries demonstrate that more than half of their GDP is generated by human capital, particularly by the intellectual contributions of the citizens residing in these countries. Education is a critical component of human capital, leading almost all countries to expand government support for the education sector. General secondary education is a crucial component of education worldwide. It provides the longest period of formal education and establishes the foundation for basic knowledge and skills. Thus, when allocating budgetary resources to general secondary education, every society aims to ensure their effective use (Alonso & Sanchez, 2011).

According to our research, there is no clear correlation between the average monthly salary financed by budget expenditure and the academic performance of school graduates who took the EIE tests (see Figure 2). Therefore, it is necessary to develop new approaches and quantitative methods to assess the efficiency of budget spending on general secondary education. In general, the assessment of efficiency (the ratio of the performance to the costs of achieving it) can be carried out using the DEA method (Charns et. al., 1978). In the study (Londar et. al., 2022) this method has been adapted for use in the field of secondary education. When implementing the adapted method at the regional level, it is crucial to create a dataset that includes information on the costs and data on the performance of education. To achieve this, the study uses official reports from the State Treasury Service of Ukraine on the educational subvention funds for teachers' salaries allocated to each community in 25 Ukrainian regions during 2020-2021 to gather cost data. It is shown that there is a relationship between these indicators and it is most likely linear, with a coefficient of determination of 0.30-0.38 indicating a moderate correlation. Thus, both one-year and two-year funding data can be used in cost calculations. At the same time, the use of two-year financing data is more justified, since the results of the EIE may be influenced by the financing of previous periods. In addition, it should be noted that the current year's funding is only partially used at the time of the EIE.

In order to demonstrate the performance (beneficial effect) of education, it is essential to measure it quantitatively using a consistent methodology across all regions of Ukraine. To achieve this, we used data from the annual national EIE, which is conducted at a national level with a consistent methodology. This allows for a comparison of the educational performance of school graduates from different regions of Ukraine. In the future, these data may be supplemented by the results of the state final attestation of graduates of all levels of general secondary education, as provided for by legislation. When presenting the performance of education, it is important to consider additional indicators that may indicate the quality of education. These indicators include the percentage of students who participated in the EIE and passed the pass/fail threshold, as well as the percentage of students who received more than 180 points. The performance indicators obtained in this work appear to be realistic. For instance, Figure 4 illustrates that the efficiency of budgetary funds for general secondary education is higher in the main university cities of Ukraine, namely Kyiv, Kharkiv, and Lviv. This suggests that the adapted DEA method can be used to estimate the efficiency of budgetary funding of education not only in Ukraine but also in other countries, where similar data on costs and data on education performance are available.

In our study, the DEA method is extended to perform the task of estimating the effectiveness of education in individual subjects. This approach allows the creation of a visualization using a risk-oriented approach, represented as a thermal matrix of efficiency. Such a matrix can be used as a management tool for state authorities to assess the efficiency of education in different regions and to help plan measures to improve education policy.

At the same time, it is important to emphasise that the results presented refer exclusively to the educational performance of the activities of general secondary education institutions, in the form of EIE results. In particular, some of these institutions see their mission as providing maximum EIE results in all subjects. Conversely, some institutions focus on maximising results in specific subjects and developing related competencies, such as language, digital skills, and mathematics, etc. They achieve this by reducing the amount of study time spent on lower-priority subjects. Other institutions prioritise aspects unrelated to EIE subjects, such as excellence in sport or the arts, promoting students' socialisation and addressing their health needs. In terms of educational results, they may focus on achieving results that are minimally acceptable from the perspective of state standards for secondary education. In the future, a more detailed analysis of these issues will be carried out by categorising results according to relevant characteristics rather than according to regions (local communities).

It is important to note that the results obtained by the DEA method, as well as other multi-criteria evaluation and optimisation methods, can be significantly influenced by the choice of indicators and their weighting coefficients. Therefore, it should be complemented with additional data. In particular, the results of our study are consistent with the fact that the highest performance indicators are found in Kyiv, the capital of Ukraine, and regions with major university centres. These

areas have the best human potential and the material and technical resources necessary for high-quality secondary education.

Changes in budget financing and the replacement of the EIE by the NMT in 2022 (in particular, changes in conditions and procedure of the nationwide examination of school graduates due to the mass migration of students and teachers during martial law) limit the possibility of using the adapted DEA method. Therefore, one of the future vectors for the continuation of this research is the creation of an approach for assessing the efficiency of budgetary financing of education under such extraordinary conditions.

CONCLUSIONS

The issue of assessing the efficiency of budgetary support for general secondary education is of global relevance, as general secondary education is a key element in the educational trajectories of citizens in all countries and plays a fundamental role in the development of human capital.

The study substantiates a general approach to the task of assessing the efficiency of budgetary financing of general secondary education using the example of Ukrainian regions. It is shown that an effective method for such an evaluation can be the adapted DEA method previously proposed by the authors.

The authors created a dataset based on official data from the State Treasury Service of Ukraine on budgetary expenditure on education, as well as a dataset of indicators from the EIE on school graduates, which can be used to create performance indicators. The calculated values of the efficiency of budget financing by regions of Ukraine show that the efficiency is higher in regions with "university" centres: Kyiv city, Kharkiv and Lviv regions. This is consistent with the general idea of the influence of such centres on the quality of secondary education.

The full-scale aggression of the Russian Federation against Ukraine and the introduction of martial law led to changes in the procedures and conditions for conducting external evaluations of graduates in Ukraine in 2022, resulting in a loss of information in terms of generating a dataset on the performance of education. This highlights the need for additional research on cost-performance metrics that are important for the use of the DEA method in emergency situations under martial law.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

All authors have contributed equally.

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CONFLICT OF INTEREST

The Authors declare that there is no conflict of interest.

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ОЦІНЮВАННЯ БЮДЖЕТНОЇ ЕФЕКТИВНОСТІ ЗАГАЛЬНОЇ СЕРЕДНЬОЇ ОСВІТИ В УКРАЇНІ

Українська система освіти продемонструвала свою стійкість, продовжуючи функціонувати навіть у несприятливих умовах війни. Урядом здійснено широкий спектр заходів щодо внесення змін до законодавства та нормативно-правових актів, завдяки цьому заклади освіти, педагоги та учні змогли адаптуватися до умов воєнного стану. Запроваджено нові інструменти для управління, навчання, бюджетного фінансування. Останні завдяки своїй універсальності впливають на всі аспекти освітнього процесу. Метою дослідження є розвиток нових підходів до оцінювання ефективності бюджетних видатків на загальну середню освіту й на державному, і на регіональному рівнях, зокрема вивчення можливостей використання для такого оцінювання адаптованого методу Data envelopment analysis (DEA). Кількісне оцінювання ефективності бюджетних видатків на освіту методом DEA проведене для передвоєнного періоду (2020-2021 роки), для воєнного періоду (2022 рік) використано статистичні методи дослідження, оскільки під впливом воєнного стану суттєво змінилась інформаційна база. При оцінюванні ефективності бюджетних видатків як вхідні показники затратності використано дані про дві складові фінансування заробітної плати вчителів у закладах загальної середньої освіти: за кошти освітньої субвенції (трансферт з державного бюджету до місцевих бюджетів для фінансування заробітної плати педагогічних працівників) та за кошти місцевих бюджетів, виділених ними на освітнє фінансування. За показники корисності освітнього процесу в розрізі регіонів взято результати тестування випускників шкіл у рамках національного зовнішнього незалежного оцінювання у 2020-2021 роках – з української мови та літератури, історії України, математики й англійської мови. Створено «теплову матрицю» індикаторів ефективності бюджетного фінансування в розрізі регіонів, яка є ризикоорієнтованим управлінським інструментом, що сприяє виявленню освітніх проблем та дає змогу регіональним управлінцям формувати більш ефективну освітню політику. Загалом підтверджено дієвість адаптованого методу DEA для оцінювання ефективності бюджетного фінансування сфери загальної середньої освіти. Особливості використання методу для періоду воєнного стану буде глибше досліджено в наступних роботах.

Ключові слова: ефективність бюджетного фінансування; метод DEA, загальна середня освіта, теплова матриця індикаторів ефективності фінансування, показники затратності та корисності освітнього процесу

JEL Класифікація: H52, I22, I28