

UDC 336.1:378:331.101.262

DOI: 10.57111/econ/3.2024.69

## Volodymyr Ponomarenko

Doctor of Economics, Professor  
Simon Kuznets Kharkiv National University of Economics  
61166, 9A Nauka Ave., Kharkiv, Ukraine  
<https://orcid.org/0000-0002-9702-8469>

## Oksana Pysarchuk\*

PhD in Economics, Associate Professor  
Simon Kuznets Kharkiv National University of Economics  
61166, 9A Nauka Ave., Kharkiv, Ukraine  
<https://orcid.org/0000-0001-6674-9223>

## Analysis of the impact of the volumes of state commissioning on the economy's availability of specialists in certain professions

■ **Abstract.** In Ukraine, there are imbalances between the specialities of graduates of higher education institutions and the needs of the market, so the issue of studying the possibilities of state influence on increasing the popularity of strategically necessary professions for the development of the country through the state-commissioned education is relevant. The purpose of the study was to determine how changes in the volume of state orders affect the choice of professions and competitive scores, and to develop recommendations for optimising the national policy in the field of financing specialities important for the country's economic development. Clustering of specialities by the number of applicants enrolled for training was carried out, trends in changes in clusters in dynamics for 2018-2023 were considered, forecast models for changes in the number of applicants for each of the clusters were constructed, and correlation dependencies were determined on the impact of changes in the volume of state orders on attracting capable applicants to the speciality. The results of clustering, the visualisation of which is carried out using graphical methods, to a certain extent determine the popularity of the relevant professions and specialisations among applicants, including the level of sensitivity of the choice of applicants to the influence of external factors. It was determined that fluctuations in the number of applicants in small specialities occur within 1% despite significant changes in the share of state-funded places financed by budgetary funds, but in the cluster of specialities with a large number of applicants, such fluctuations are within 10%. The practical significance of the study lies in the possibility of using the constructed models for each speciality to determine their sensitivity to the impact of changes in the amount of funding for state-commissioned education, which would optimise the distribution of financial resources for training specialists for sectors of the economy

■ **Keywords:** budget financing; training of specialists; clustering of specialities; imbalances; attractiveness; financial support

## ■ INTRODUCTION

The quality of specialist training and higher education has a significant impact on the quality of the country's human capital. In the context of the post-war recovery of the

country's economy, human capital will be of paramount importance for the pace of recovery and development of the country's economy. In conditions of limited funding,

Article's History: Received: 21.03.2024; Revised: 07.08.2024; Accepted: 30.09.2024

## Suggested Citation:

Ponomarenko, V., & Pysarchuk, O. (2024). Analysis of the impact of the volumes of state commissioning on the economy's availability of specialists in certain professions. *Economics of Development*, 23(3), 69-81. doi: 10.57111/econ/3.2024.69.

\*Corresponding author



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inefficient use of available financial resources from various sources for training specialists with higher education is unacceptable. The issue of the effectiveness of using funds in the current system of financing the training of specialists with higher education in Ukraine remains open. Improvement of the solution requires a number of issues, including the system of financing higher education institutions (HEIs) and training of specialists with higher education, which are necessary for the restoration and development of the country's economy; the system of developing a state order for training specialists of relevant profession from the moment of determining the need for specialists of certain specialities to ensure their quality training; the development and implementation of a system of motivations for attracting more capable education applicants, and then work in areas that are most important for the restoration of Ukraine; the discrepancy between the structure of specialists and the existing and promising strategic needs of the market in Ukraine.

The place of human capital cannot be underestimated, and O. Kuzmin *et al.* (2020) examined its role in the development of the country's economy. Hostilities in Ukraine have a negative impact on all components of socio-economic life, including the development of human capital. The quality of human capital is determined by several components. G. Nazarova & V. Rudenko (2022) identified three main components: "demographic component", "development of the education system", and "development of the healthcare system". With the outbreak of hostilities, more than 6 million people left the territory of Ukraine, more than 60% of them have higher education (Survey: Attitudes of Ukrainian refugees, 2023). More than two years later, 2.4 million people remain outside the country. According to experts' forecast estimates, most of them do not plan to return back to Ukraine. Such a part of the working-age population and their children become irretrievable losses for the country's human capital both at the current time and in the future. Teenagers who have incurred the cost of forming the basic foundations of the "education" and "health" components by the state, and who enter the labour market after a certain time, will be involved in creating the national income of another country, and not Ukraine.

T. Vasylytsiv *et al.* (2022) focused on the impact of migration processes, internal movement of citizens, businesses, as a result of active military operations on the territory of Ukraine, on the aggravation of imbalances and imbalances in the labour market on the example of the western region of Ukraine. They considered the issues of business relocation and the problem of equivalent mixing of employees. Special emphasis is placed on imbalances in the context of industries and areas of state policy to level significant gaps. The researchers also propose ways to stabilise the labour market in the post-war period. The study by A. Vorontsova *et al.* (2021) stressed the importance of an integrated approach to the study and resolution of labour market imbalances, including the interaction between market mechanisms and government regulation, and the adaptation of educational processes to market needs. The researchers focused on identifying the causes that lead to these imbalances, in particular in certain professional groups and sectors of the economy. They investigated how the uneven development of different sectors

of the economy creates imbalances in the labour market and focused on the need for more active government intervention through educational programmes, employment policies, and other mechanisms.

V. Chekina & O. Vorhach (2020) conducted an empirical analysis of the relationship between education costs and labour market indicators. They considered generalised indicators of the labour market and unemployment without identifying problems in individual specialities. The effectiveness of the use of educational resources and their impact on the country's development potential was investigated by H. Liao *et al.* (2024). The researchers considered more than 30 European countries. They noted the close link between the country's productivity and the quality of education, focusing on the importance of providing high-quality higher education. They also investigated problems that lead to gaps in education. V. Usyk (2019) stressed that in the structure of Ukraine's gross domestic product, the share of spending on education corresponds to the average level of European countries. The scientist emphasised that the main problem lies precisely in the distribution of these funds, both between the levels of educational institutions and between institutions of the same level, suggesting improvements in the financing mechanism through the establishment of certain financial rules.

The researchers of the current study hypothesised that only the use of state order volumes as a tool for influencing the choice of the applicant's future profession does not ensure the development of the necessary structure for the Ukrainian economy of training specialists in various professions. In contrast to the statement of the leadership of the Ministry of Education and Science of Ukraine, and the position of the Cabinet of Ministers of Ukraine, about providing the country's economy with the necessary professions precisely through the financing of training in such specialities (The principle..., 2024). The purpose of the study was to comprehensively analyse the relationship between changes in the amount of state funding for training specialists in certain professions and their impact on the attractiveness of such specialities for applicants, and to determine the effectiveness of such influence for popularising specialities that are strategically important for the post-war reconstruction of Ukraine and its development.

## ■ MATERIALS AND METHODS

The study was based on information on the recruitment of higher education applicants for the bachelor's degree (USEDE, n.d.), based on complete general secondary education in the period 2018-2023, and identified factors that affect the number of applicants enrolled in a particular speciality and specialisation. During the study period, there was a fluctuation in the total number of positions, namely, specialities and specialisations for which recruitment for training was carried out in the range of 191-216 positions, which were further considered in the study. Further, clustering was carried out to identify five clusters of specialities and specialisations, depending on the number of applicants who chose the appropriate profession, and who are enrolled in each speciality at the bachelor's educational level based on full general secondary education. This distribution acts as a certain indicator of the popularity of the speciality among applicants. The study covered specialities

and applicants for education who study at HEIs, which are subordinate to one administrator of budget funds, namely the Ministry of Education and Science of Ukraine.

Using the capabilities of the built-in functions and add-ons of the Microsoft Excel software suite, forecast models were built to determine the forecast number of applicants in the specialities of each of the clusters to determine the dynamics of changes in the average number of applicants in the forecasting speciality, carried out through the function of linear and nonlinear dependencies. The use of the Python software product, statsmodels application, helped to construct a pair linear regression equation for each speciality, which describes the dependence of two variables, namely, changes in the volume of the state order for training applicants for education in a particular speciality, which determines the change in state support for financing the training of relevant specialists, and changes in the competitive entrance score for enrolment in such a speciality. The level of the competitive entrance score characterises the attractiveness of the chosen profession for the most capable applicants. Correlation and determination coefficients were also determined for each model. The results were summarised using the built-in functions of the Microsoft Excel toolkit. The use of the built-in average value function (AVGVAL) ( $\bar{X}$ ) for the data array of the Microsoft Excel software determined the average value of a series of data, namely, the number of enrolled applicants per speciality, for each of the periods.

$$X_{avg} = \frac{\sum_{i=1}^n X_i}{n}, \quad (1)$$

where  $X_{avg}$  – mathematical average of a number of values of enrolled applicants for a particular speciality;  $X_i$  – current value of the value and data series,  $i \in [1; n]$ ;  $n$  – number of members of the group (number of majors and specialisations for which applicants were recruited through a broad competition). Amplitude of fluctuations in the weight fraction of incoming users:

$$\Delta W_i = W_i^{max} - W_i^{min}, \quad (2)$$

where  $W$  – fluctuations in the share of applicants. The method of graphical visualisation was used to analyse the structure and dynamics of popularity of specialities through the analysis of quantitative characteristics of clusters of specialities for which the recruitment of educational applicants for each cluster was carried out. This helped to identify high risks of forming incomplete groups. The paper used tools for economic and mathematical forecasting. To construct predictive models for the absolute number and relative share of applicants for each of the clusters, indicating the type of trend line function calculated by the mathematical equation. A more detailed analysis of the structure of each cluster, trends, and factors that affect them was carried out using the index method. The use of relative indicators was one of the tools for identifying trends in economic phenomena and processes. The index method tools were used, on the one hand, to measure a phenomenon in a time section, and on the other, to compare elements that describe the same phenomenon, but have different meters. A comparative analysis of the results of the admission campaign, identification of factors of influence, and trends was carried out by converting data

series, such as the volume of state orders placed through a broad competition, the minimum competitive score, and the total number of enrolled applicants, through indices to values without units of measurement, which allowed them to be included in a single system.

## ■ RESULTS

Training of specialists with higher education is carried out by HEIs of various forms of ownership, namely state, municipal, and private. HEIs in Ukraine have different departmental subordination. As of November 1, 2023, 195 state-owned HEIs were subordinated to 14 different ministries and agencies (USEDE, n.d.). Municipal HEIs are subordinate to the regional level, namely regional, city, or district. The number of government departments subordinated to 39 municipal HEIs at the regional level is much higher and amounts to 21 structures. More than 75% of all applicants for non-military specialities receive education at all levels of training in the system of the Ministry of Education and Science of Ukraine. In accordance with the current regulatory framework in Ukraine, higher education in specialities is provided at the expense of budgetary funds and at the expense of individuals and legal entities (Law of Ukraine No. 1556-VII, 2014; Resolution of the Cabinet of Ministers of Ukraine No. 708, 2023; Procedure for Admission to Higher Education in 2023, 2023). In Ukraine, to a certain extent, a system of joint financing of the process of training specialists with higher education is being implemented. These issues are discussed in detail in the paper by V. Ponomarenko (2021).

The number of places for which training is financed from budget funds is defined as the volume of state orders for a speciality. Applicants with the highest rating (passing, competitive) score are enrolled in budget places. The applicant's competitive score determines the possibility of entering a university in the chosen speciality and the possible form of financing. The result of the entrance campaign is determined by the number of applicants enrolled in the relevant specialities and specialisations for which competitive proposals were developed. The level of competitive passing score in a particular speciality can be considered as an indicator of its popularity among applicants, and as evidence that this particular speciality attracts the most capable applicants. If applicants with high scores are enrolled in field training under a state order, this indicates that the state invests in the education of the most capable students, thereby contributing to the training of highly qualified and competitive specialists in this speciality for the future labour market.

It should be noted that there is a significant differentiation in the number of enrolled applicants in various specialities. This is determined by the needs of the market and the state through quantitative indicators of targeted placement of state orders, and the preferences of applicants and their parents, their personal ideas about the possibilities of their own implementation in a particular profession, etc. As part of the study, five clusters of specialities were developed in terms of the number of enrolled applicants from the minimum to 100 people – this is the 1<sup>st</sup> cluster to a significant number – more than 2,000 people – the 5<sup>th</sup> cluster. The number of applicants enrolled in the educational level of bachelor based on full general secondary education for

each speciality and specialisation, except for the military, for budget funds and funds of individuals and legal entities, determine whether such a speciality belongs to the cluster.

The dynamics of changes in the number of specialities in each of the clusters during 2018-2023 is shown in Figure 1. The so-called distribution by popularity of the speciality.

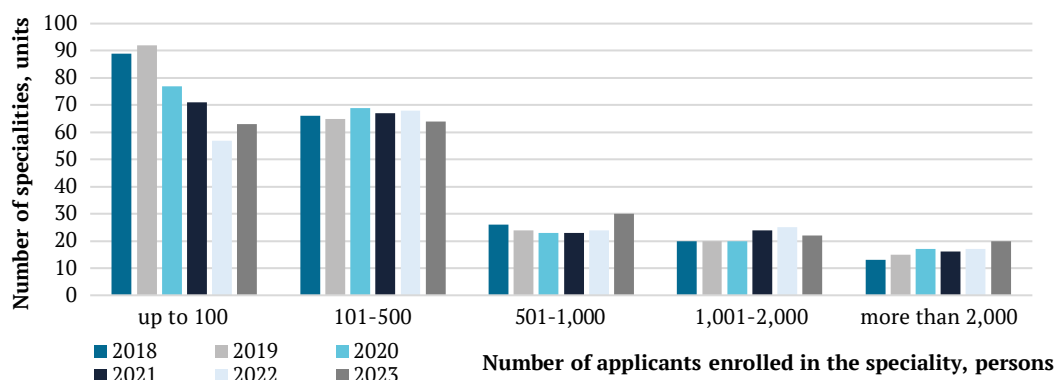


Figure 1. Results of clustering specialities by set of applicants

Source: compiled by the authors based on USEDE (n.d.)

The 1<sup>st</sup> cluster is a group of small specialities and specialisations, which have less than 100 people enrolled in all Ukrainian HEIs. Since 2019, the number of such specialities and specialisations is gradually decreasing and amounts to 57 positions in 2022 against 89 in 2018 and 92 in 2019, respectively, but in 2023 it was 63 positions. The 2<sup>nd</sup> cluster includes a list of specialities and specialisations, in which the total number of applicants enrolled in the budget and contract form of funding is from 101 to 500 people for each. The number of specialities that fall into the 2<sup>nd</sup> cluster remains almost unchanged, fluctuating in the range of 64-69 positions. The 3<sup>rd</sup> cluster includes specialities with 501 to 1,000 students, and their number is also quite stable, ranging from 23-26 positions from 2018 to 2022, and 30 in 2023. The 4<sup>th</sup> cluster includes specialities and specialisations with 1,001 to 2,000 students enrolled in each of them under contract and budgetary forms of funding. The number of such specialities is 20-25 positions. The most popular specialities among applicants for education, for

which more than 2,000 people are enrolled at the expense of the budget and at the expense of individuals and legal entities, are assigned to the 5<sup>th</sup> cluster. The 5<sup>th</sup> cluster includes 13-20 positions of specialities and specialisations, which is 6-10% of the total number of specialities for which training is carried out.

The researchers state that training in small specialities and specialisations (the 1<sup>st</sup> and 2<sup>nd</sup> cluster), where the number of enrolled applicants for education is less than 500 people throughout Ukraine, accounts for 130-160 specialities, depending on the year, which is 65.0-72.7% of the total number of specialities and specialisations for which applicants for education are recruited. Table 1 shows examples of small numbers of specialities and specialisations that, based on the results of clustering, are assigned to the first cluster, with the number of bachelor's degree students up to 100, and a list of specialities that, based on the results of the 2023 enrolment, are assigned to the 5<sup>th</sup> cluster with the number of bachelor's degree students over 2,000.

Table 1. Examples of individual specialities and specialisations of the 1<sup>st</sup> and 5<sup>th</sup> clusters with the number of enrolled applicants on budget and contractual basis in 2023

Example of specialities and specialisations of the 1 <sup>st</sup> cluster	Number of applicants	Specialities and specialisations of the 5 <sup>th</sup> cluster	Number of applicants
015 "Professional Education" (015.34 "Mechanical Engineering")	84	081 "Law"	8,656
112 "Statistics"	77	073 "Management"	7,399
145 "Renewable Energy and Hydropower"	76	053 "Psychology"	7,058
015 "Professional Education" (015.35 "Mining, Processing and Transportation of Minerals")	70	122 "Computer Science"	6,707
035 "Philology" (035.060 "Eastern Languages and Literatures, first – Arabic")	66	121 "Software Engineering"	4,684
015 "Professional Education" (015.36 "Technology of Light Industry Products")	54	075 "Marketing"	4,443
035 "Philology" (035.052 "Romance Languages and Literatures")	48	192 "Construction and Civil Engineering"	4,309
014 "Secondary Education" (014.023 "French Language and Foreign Literature")	37	035 "Philology" (035.041 "German Languages and Literature, first – English")	4,171

Table 1. Continued

Example of specialities and specialisations of the 1 <sup>st</sup> cluster	Number of applicants	Specialities and specialisations of the 5 <sup>th</sup> cluster	Number of applicants
015 "Professional Education" (015.32 "Electronics, Metrology and Radio Communications")	30	017 "Physical Education and Sports"	4,126
224 "Technologies of Medical Diagnostics and Treatment"	26	201 "Agronomy"	3,579
015 "Professional Education" (015.31 "Construction and Welding")	25	141 "Electric Power Industry, Electrical Engineering and Electromechanics"	3,452
015 "Professional Education" (015.33 "Power Engineering, Electrical Engineering and Electromechanics")	23	051 "Economy"	3,239
226 "Pharmacy, Industrial Pharmacy"	22	125 "Cybersecurity and Information Protection"	2,870
015 "Professional Education" (015.15 "Occupational Health and Safety")	10	181 "Food Technologies"	2,705
011 "Educational and Pedagogical Sciences"	3	076 "Entrepreneurship and Trade"	2,378

Source: calculated by the authors based on USEDE (n.d.)

Clusters 1 and 2 mainly include speciality 035 "Philology" by language groups, and specialities 014 "Secondary Education", 015 "Professional Education". These are specialities and specialisations with extremely low popularity. Only the specialisation 035.041 "German Languages and Literature, first – English" of the speciality 035 "Philology" has a high attractiveness and is included in the 5<sup>th</sup> cluster. The average number of bachelor's degree applicants for the available competitive offers, i.e., for the specialities and specialisations for which the recruitment of applicants is carried out through a broad competition for the period under study, was calculated using Microsoft Excel. The calculations helped to determine the average number of applicants who were enrolled in specialities and specialisations for each of the periods.

$$X_{avg_{2018}} = 631;$$

$$X_{avg_{2019}} = 687;$$

$$X_{avg_{2020}} = 730;$$

$$X_{avg_{2021}} = 749;$$

$$X_{avg_{2022}} = 799;$$

$$X_{avg_{2023}} = 776.$$

There was a positive trend in the average number of applicants per speciality from 2018 to 2022, which was the result of a reduction in the number of small specialities and specialisations and their actual consolidation, but in 2023 the average number decreased. A predictive mathematical model of changes in the average number of applicants in the speciality is constructed in the form of a linear trend:

$$y = ax + b;$$

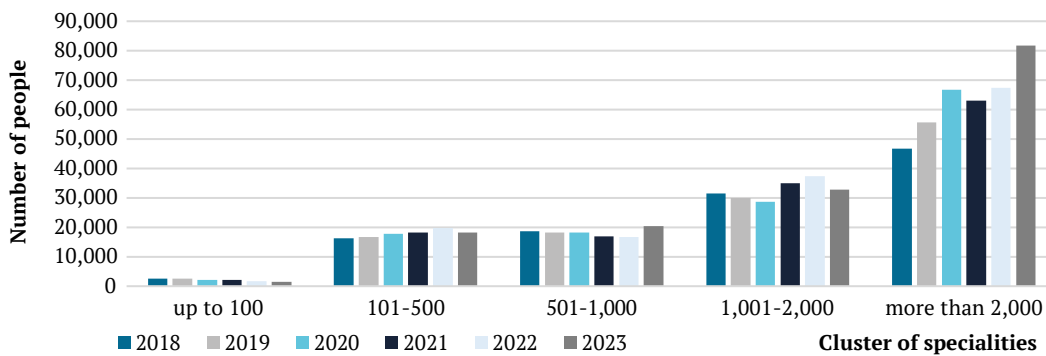
$$y = 30.857x + 620.67;$$

$$R^2 = 0.8827.$$

Coefficient of multiple determination ( $R^2$ ) confirms a high level of reliability of the model. The forecast model indicates an upward trend in the average number of applicants enrolled in a particular speciality or specialisation. Two clusters consist of specialities in which the set of applicants is lower than the average in Ukraine, two more clusters consist of specialities in which the set of applicants is higher than the average in Ukraine, and one cluster, which includes specialities with the volume of enrolment of applicants that are close to the average level. The method of graphical visualisation revealed that significant quantitative changes in the list of positions of specialities and specialisations for which bachelor's degree applicants were recruited occurred in the 1<sup>st</sup> cluster of specialities with the lowest total number of enrolled applicants, up to 100 people per speciality in the country. The number of small specialities and specialisations from 2019 to 2022 decreased from 92 to 57, but in 2023 it was 63, and the number of positions for which enrolment was carried out for the same period as a whole decreased by 11.5%. This was a consequence of transformational processes among small specialities due to the addition of some specialities to others, the closure of recruitment, etc. An increase in the number of small specialities in 2023 indicates an increase in polarisation among the priorities of applicants and an increase in the number of low-demand specialities. In the total number of specialities and specialisations for which applicants for higher education are recruited, with the exception of military ones, the share of specialities with a small number of applicants up to 500 people (clusters 1 and 2) is about 70%. Almost 70% of specialities are not popular among applicants for education, that is, applicants and their parents do not see any prospects in the future. Along with this, there are specific specialities in which a limited number of applicants for education should be trained. A significant branching of small specialities carries high risks of forming small, incomplete groups, for the training of which a smaller amount of funds will actually be attracted from various sources of funding, namely from general and special funds (Ponomarenko, 2021).

Insufficient funding for the training of applicants for such groups leads to a combination of negative consequences. Reducing the possibility of ensuring the educational process at a high level, which meets modern advanced requirements, affects the quality of training of specialists who are trained both for budget funds and for the funds of individuals and legal entities. Deterioration of the quality of training of specialists negatively affects the development of human capital, both in the short and long term. It also causes image losses of the higher education system as a whole. Insufficient funding for the training of specialists, combined with its negative consequences, actually becomes an irrational use of both financial resources, budget funds, and funds of individuals and legal entities, and human resources.

The approach proposed by V. Ponomarenko (2022), to prevent the dispersion of budget funds through the introduction of regulatory mechanisms at the stage of formation of competitive proposals by HEIs, and limiting the possibility of enrolment in places at the expense of the state budget, in specialities and specialisations in which a certain HEI has formed incomplete small groups in recent years. The quantitative distribution of specialities by clusters differs significantly from the distribution of the total number of applicants enrolled in these specialities by certain clusters for budget funds and funds of individuals and legal entities. The total number of applicants for budget and contract forms of education who are enrolled in the specialities of the corresponding clusters is shown in dynamics in Figure 2.



**Figure 2.** Dynamics of the total number of applicants enrolled in the specialities of each of the clusters  
**Source:** compiled by the authors based on USEDE (n.d.)

13-20 specialities and specialisations of the 5<sup>th</sup> cluster with the largest set during the study period account for from 40% to 50% of all applicants, excluding military specialities. This is a group of the most popular and popular specialities. In absolute terms, the total number of applicants in these specialities has increased. A wide range, within 10%, of fluctuations in the proportion of applicants in the total number of applicants who choose specialities of the 5<sup>th</sup> cluster indicates the presence of a set of factors that influence the applicant's decision about the future profession. However, more than 140 specialities and specialisations (65-73% of the total number), which enrol up to 500 people (clusters 1 and 2), account for less than 15% of all applicants for education. Fluctuations in the share of applicants for cluster 1 and cluster 2 in 2018-2023 occurred within 1.0% for each cluster. That is, the share of applicants who choose such small specialities and specialisations for higher education remains quite stable from year to year and almost does not change. This is directly conditioned by the specific features of the specialities and specialisations that are included in these clusters. This confirms the hypothesis that there is a limited list of specialities with a low level of sensitivity to the influence of external factors regarding their attractiveness. Changes in existing external factors have almost no effect on changing the attractiveness of such specialities.

The amplitude of fluctuations in the weight share of applicants enrolled in specialities of clusters 3 and 4 is in the range of 4.5-6.0%. Thus, the share of incoming specialities of the 3<sup>rd</sup> cluster with the number of 501-1,000 people

varies from  $W_3 \min = 11.76\%$ , up to  $W_3 \max = 16.19\%$ . Share of applicants for specialities of the 4<sup>th</sup> cluster with the number of 1,001-2,000 people from  $W_4 \min = 21.42\%$ , up to  $W_4 \max = 27.26\%$ . According to the specialities of these clusters, there are additional factors that influence the choice of the applicant regarding the future line of training, which caused fluctuations in the share of applicants in different periods compared to the factors of choosing specialities of clusters 1 and 2. The largest amplitude of fluctuations between the minimum and maximum share of applicants was found in the specialities of the 5<sup>th</sup> cluster, which is 9.65%. The amplitude of fluctuations in the proportion of applicants who choose one or another speciality depends on a combination of factors. The almost stable share of applicants who chose small specialities of clusters 1 and 2, with a fluctuation of 1%, indicates a low level of sensitivity to factors that affect the choice of applicants. A well-established part of society prefers training in certain specialities and specialisations. And neither socio-economic, nor political factors, nor other factors have a significant impact on their choice. The amplitude of fluctuations in clusters of specialities and specialisations with a set of more than 500 people ranges from 5% to 10%, which indicates an increased level of sensitivity of such specialities. That is, the decision to choose a speciality is influenced by a combination of additional factors.

Figure 2 indicates different dynamics of changes in the indicators of each cluster, both in the direction of growth or decline, and in the nature of changes linear or nonlinear. The tendency of a series to change in the time dimension

is a trend (Gupta *et al.*, 2024) and can be described using a mathematical equation. Table 2 shows the results of constructing forecast models for the absolute number and relative share of applicants for each of the clusters, indicating

the type of trend line function, the calculated mathematical equation, and the coefficient of determination  $R^2$ , which characterises the degree of reliability of the constructed forecasting model.

**Table 2.** Forecast models of the number and share of applicants enrolled in specialities in the context of each cluster

Cluster	Type of functional dependency	Mathematical equation	$R^2$
Total number of applicants			
1	Linear	$y = -195.9x + 2,808.1$	0.9129
2	Linear	$y = 837.6x + 15,220$	0.9584
3	Polynomial	$y = -51.071x^2 - 213.07x + 19,006$	0.988
4	Polynomial	$y = 1,109.4x^2 - 4,991x + 35,228$	0.8663
5	Polynomial	$y = -1,748.9x^2 + 15,377x + 33,002$	0.9149
Relative share of applicants			
1	Linear	$y = -0.2408x + 2.4544$	0.956
2	Polynomial	$y = 0.1397x^2 - 0.9046x + 14.815$	0.9906
3	Linear	$y = -1.1208x + 17.162$	0.9913
4	Polynomial	$y = 0.9842x^2 - 5.978x + 32.089$	0.6672
5	Polynomial	$y = -1.2079x^2 + 8.7483x + 32.891$	0.8567

**Source:** calculated by the authors

The high level of reliability of models that are built is indicated by high values  $R^2$ , which is close to 1. The exception was the forecast model of changes in the relative share of applicants in cluster 4, according to which  $R^2 = 0.6672$ , which indicates an acceptable level of reliability of the model. The heterogeneous dynamics of enrolment volumes in specialities of different clusters makes it necessary to conduct a further detailed analysis of the factors of influence for each cluster separately. The provision of state-ordered places indirectly acts as an indicator of the level of state support for a particular speciality. The state, through the relevant managers of budget funds, carries out orders for the training of specialists at each of the levels, in the amounts that it determines as necessary, through the volumes of the state order that are formed for each speciality and specialisation. Within each cluster, the average percentage of applicants who are enrolled in places funded from budget funds is determined as the average value for each speciality of the cluster.

The results obtained indicate that the financing of training of specialists in the specialities included in the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> clusters, that is, with the number of up to 1,000 people, on average by 50% or more is carried out at the expense of budget funds, except for 2022 and 2023. The amount of funding for specialities assigned to the 4<sup>th</sup> cluster, with a number of 1,001 to 2,000 people, at the expense of budget funds on average for the group ranges from 40% to 50%, except in 2023. The lowest share of budget funding on average is provided for the training of applicants for higher education in the specialities of the 5<sup>th</sup> cluster, which are most popular among applicants. The average percentage of budget funding ranges from 23.5% in 2020 to 30% in 2022.

An economic analysis of the results of the impact of changes in state support for specialities, through the volume of investment in the training of specialists under the state order in certain specialities, revealed the following. In the specialities of the 5<sup>th</sup> cluster that are most popular among applicants, with a total number of enrolled applicants of more than 2,000 people, the following trends are obtained. From 2018 to 2020, the share of places for which

applicants were enrolled at the expense of the state budget decreased from 28.5% to 23.5%, while the total number of applicants who chose the specialities of this cluster increased, both from 2018 to 2020, and in subsequent periods. Despite the obvious trends in reducing state support through funding for the training of specialists, this did not affect their popularity among applicants. This indicates that the decline in state support was not a decisive factor in changing the popularity of these specialities, moreover, the influence of this factor was offset by others. The number of applicants has increased, which may be due to other factors, such as the demand for specialists in these areas in the labour market or the prestige of these specialities in society.

Analysis of fluctuations in the share of places funded by the state budget in the specialities of the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> clusters (with the number of enrolled applicants up to 1,000 people) revealed that changes in the range from 43% to 56% almost did not affect the total number of enrolled applicants. This shows that, despite variations in the share of state funding and investment in training in certain specialities, and a large share of places for training for budget funds, this does not increase the popularity of specialities in these clusters. This result may indicate that for specialities with fewer applicants (few popular specialities), the key factors of choice are other circumstances, and not just the volume of the state order.

Correlation of the results of the analysis of the dynamics of the share of places funded by budget funds by clusters of specialities with fluctuations in the dynamics of the share of applicants who choose specialities in these clusters gives grounds to draw the following conclusions. Fluctuations in the share of places with budget funding in the range of 43–56% in the specialities of clusters 1 and 2 did not affect the choice of applicants. Fluctuations in the total share of persons enrolled in specialities and specialisations of the 1<sup>st</sup> and 2<sup>nd</sup> clusters during 2018–2023 are observed in the range of only 1%. This indicates that to increase the attractiveness of certain specialities that are strategically necessary for the development of the country, the use of only one lever of influence, namely, the number of places

of state order for education, is insufficient. The thesis is actively put forward that one of the main tools for influencing the choice of an incoming future profession is the allocation of budget places (Zub & Zhezhnych, 2022) for training in the relevant speciality. Providing the country's economy with specialists that are strategically important for its recovery can be achieved by changing the structure of investment in training specialists, namely by increasing the volume of state orders for training specialists.

The authors of this study suggest that the unambiguity of the above hypothesis is debatable and not reasoned. An increase in the volume of state orders for training specialists in a particular speciality does not mean an unconditional increase in the total number of applicants for such a speciality and its popularisation. The presented results of the analysis of the dynamics of the share of budget places and the share of enrolled applicants for specialities of the 1<sup>st</sup> and 2<sup>nd</sup> clusters confirm the absence of such growth. The volume of state orders and changes in the structure of budget allocation between specialities can be only one of the levers of influence on the "attractiveness" of a particular speciality, but not always an effective tool. To test or refute the above hypothesis, paired linear regression equations were constructed for each speciality and specialisation for which recruitment was carried out during 2018-2023, which determine the presence of a relationship between indicators. The relationship between the financing of training of applicants for a certain speciality through the indicator of changes in the volume of state orders for training specialists, and changes in the popularity of the speciality, one of the evaluation characteristics of which is a change in the competitive passing score. The equation of paired linear regression, for example, for the speciality 193 "Geodesy and Land Management" has the form:

$$Y_{193} = 1.06412 \times X_{193} + 279.773.$$

The equation describes the relationship between the number of applicants enrolled in state-commissioned

training (variable  $X_{193}$  and the value of the passing (competitive) score ( $Y_{193}$ ) for the specified speciality during 2018-2023. The equation shows that as the volume of the state order increases ( $X_{193}$ ) for each additional unit, the competition score ( $Y_{193}$ ) increases by an average of 1.06412. Such a positive relationship between  $X$  and  $Y$  it indicates that with the increase in the number of places for study, which are financed from the state budget, the competitive scores of applicants also tend to increase. There is an assumption that this may indicate an increase in the interest of applicants with higher scores in admission due to an increase in the number of places allocated by the state for this speciality. More places available for public funding attract more capable applicants with higher competitive scores.

Given the weak correlation ( $r=0.4$ ), and low coefficient of determination  $R^2 = 15.94$ , this growth is not a decisive factor. The level of the correlation coefficient indicates a weak positive relationship between the change in the volume of the state order and the competitive score, which indicates a moderate influence of these factors on each other. Coefficient of determination  $R^2 = 15.94$  means that only about 15.94% of variations in the competition score can be explained by changes in state order volumes. This indicates a low explanatory power of the model, i.e., there is a combination of other factors that significantly affect competitive scores in this speciality. The statistical quality level of the model is assessed as low, which indicates that the regression model does not accurately predict changes in the competitive score based on changes in the state order. The model demonstrates how changes in the number of public places affect the average level of the competition score, which may indicate a change in the quality of applicants or political and economic priorities in the development of a state order. Similarly, the equation of paired linear regression is constructed and the coefficient is determined for each of the specialities and specialisations for which applicants to the bachelor's educational level were recruited in the period 2018-2023. The results obtained are systematised for each of the clusters and summarised in Table 3.

**Table 3.** Systematisation of clusters

Cluster	Correlation coefficient $r$ (average by cluster)	Coefficient of determination $R^2$ , % (cluster average)	% of specialities in the cluster for which the correlation coefficient is applied $r < 0$	% of models in the cluster by the level of statistical quality of the model	
				high	low
1	2	3	4	5	6
1	-0.267	39.75	66.67	18.52	81.48
2	0.085	40.24	40.38	23.08	73.08
3	-0.05	31.63	45.45	13.64	86.36
4	-0.26	37.72	60.87	21.74	73.91
5	-0.42	50.87	80.00	46.67	53.33
Total			53.96	23.02	74.82

**Source:** compiled by the authors

The summary table shows the average values of the corresponding indicators for each of the clusters. The results of the analysis show the heterogeneity of trends in each of the clusters. Cluster average value of the correlation coefficient  $r$  (column 2) reflects the average degree of linear relationship between changes in state order volumes and competitive scores within a group of specialities

belonging to the same cluster. A positive value of the coefficient indicates a general trend towards a positive relationship, that is, with an increase in the number of places under the state order, competition points also increase. A negative value of the coefficient indicates a feedback loop. The modular value of the indicator describes the strength of the relationship between variables. The average  $r$  value

close to zero indicates a weak or no linear relationship between changes in the amount of state funding for training and competitive scores for cluster specialities.

In column 4 of Table 3, the proportion of cluster specialities for which a negative correlation between the indicators is observed. With an increase in the volume of enrolment of applicants at the expense of the state order, the possibilities of admission of less trained applicants are expanding, and as a result, competition points tend to decrease. The calculation of this indicator provides a quantitative assessment of negative trends in the cluster, where an increase in state order volumes does not contribute to increasing or maintaining high passing scores. This may indicate that an increase in the state order for certain specialities does not encourage attracting more capable or talented applicants with higher competitive scores. The indicator helps to better understand the general trends in the cluster and their possible implications for the quality of student admission.

It is indicative to calculate the proportion of cluster specialities for which the level of statistical quality of the model is defined as high (column 5) and, accordingly, low (column 6). The high quality of the model means that the regression equation explains the relationship between variables well, i.e., changes in the competitive score are well predicted based on state order volumes. This indicates the reliability and accuracy of the model in this cluster. The low level of statistical quality of the models means that the model is not reliable enough to accurately predict the competitive score based on changes in state order volumes. A high percentage of models with low statistical quality indicates the presence of other influential factors, in addition to the volume of the state order, affecting the level of the competition score, and therefore, the interest of the most capable applicants to choose such specialities.

The 1<sup>st</sup> cluster, which includes the least popular specialities (less than 100 applicants), shows a negative average correlation coefficient ( $-0.267$ ) and an average coefficient of determination of 39.75%. These figures show that the number of applicants for these specialities tends to decrease, and models cannot explain changes in the data well enough. The quality of models in this cluster is one of the lowest: only 18.52% of models are of high quality, while 81.48% of models show poor quality. The 2<sup>nd</sup> cluster is characterised by a positive average value of the correlation coefficient ( $r = 0.085$ ), which indicates a weak direct relationship between indicators, but the average coefficient of determination (40.24%) indicates a slightly higher explanatory power of models compared to other clusters. The statistical quality of the 2<sup>nd</sup> cluster models is low, as only 23.08% of the models are of high quality, while 73.08% have low quality. The 3<sup>rd</sup> cluster shows a further decrease in the average coefficient of determination to 31.63%, which indicates an even lower explanatory power of the models. The average correlation coefficient approaches zero ( $-0.05$ ), which indicates that there is no clear trend in changing the number of applicants over time. At the same time, the quality level of models remains low: only 13.64% of models are of high quality, and 86.36% are of low quality. The 4<sup>th</sup> cluster (specialities with the number of applicants from 1,000 to 2,000) shows slightly different dynamics. The average coefficient of determination

decreases to 37.72%, which indicates a decrease in the ability of models to explain changes in data. The negative average correlation coefficient ( $-0.26$ ) also indicates an inverse relationship between the dependent variables. In this cluster, the percentage of specialities with a negative correlation is 60.87%. The quality level of models in this cluster is much lower: only 21.74% of models have a high level of quality, while 73.91% of models show a low level.

The 5<sup>th</sup> cluster, which includes the most popular specialities (with more than 2,000 applicants), is characterised by the highest average value of the coefficient of determination ( $R^2 = 50.87\%$ ). This suggests that in this cluster, models can explain more than half of the differences in the data. There is also a negative average correlation coefficient ( $r = -0.42$ ), which means that there is feedback between the indicators. Moreover, 80% of the cluster's specialities have a correlation coefficient of less than zero, which indicates a general trend towards an increase in the competitive passing score with a decrease in the amount of funding for places under the state order. The level of statistical quality of models in this cluster shows some inconsistency: only 46.67% of models are of high quality, while for 53.33% of models, the quality is low. This may indicate that there are objectively popular professions in the cluster, and specialities whose popularity is situational in nature and depends on the available priority opportunities, such as increasing places with budget funding.

The results obtained for different clusters indicate a significant variation in the relationship between the state order and the competition score, depending on the popularity of specialities. The results of the analysis of the summary data in the generalised table confirm the hypothesis that the dynamics of changes in the volume of state orders is not a determining factor in attracting more capable and talented applicants with high competitive scores to enrol in specialities that are not widely popular among applicants, but are strategically important for the development of the state. The constructed regression models show that even an increase in the number of public places in certain specialities does not guarantee the attraction of applicants with high academic achievements. This indicates that the popularity of the speciality among applicants largely depends on other factors, such as the prestige of the profession in the labour market, prospects for further employment, social significance, and general economic and social conditions. Even if the state increases funding for specialities of strategic importance, this does not necessarily contribute to attracting the best applicants with high entrance scores.

Summary data also show that specialities with low popularity among applicants tend to reduce competition scores, even in the face of a stable or increased state order. This confirms the conclusion that in order to attract more talented students to such specialities, it is necessary to apply other, additional incentive mechanisms that go beyond increasing state funding. The study of the impact of changes in the volume of state orders on the competitive scores of applicants, which reflects the attractiveness of specialities, is important in the context of research on the development of human capital. Changes in the volume of state orders can affect the qualitative composition of future specialists in a particular profession, because an increase in state funding due to an increase in the number of

places state-commissioned education does not always contribute to attracting talented applicants. This is important for the development of human capital, since the high level of knowledge and competencies of graduates determines the economic development of the country and its ability to innovate.

It is proved that the growth in the number of places where applicants are trained for budget funds, that is, the growth in the volume of state orders for training specialists in the specialty, is not an absolute factor in the growth of popularity, attractiveness of such specialties, the growth in the number of applicants enrolled in such specialties and does not correlate at all with the involvement of the most capable applicants for these specialties. Changes in the amount of state funding for the training of specialists have different effects on the attractiveness of specialties, but this factor is not the only one that determines. For some specialties, government support is a crucial factor, while for others it may not play a significant role. The popularity of a speciality depends on market conditions, employment prospects, the prestige of the profession and the level of awareness of applicants about future prospects, and the attitude of society towards representatives of the speciality. For strategically important specialties, it is necessary to implement comprehensive measures, including career guidance, an information campaign and material incentives, etc. Along with additional incentives in the learning process through budget support for educational applicants, it is important to introduce information campaigns to promote the speciality, create transparent and attractive career opportunities that increase the value of choosing certain specialties, and create conditions for high-quality training in specialised educational institutions. It is a set of measures that will provide the necessary number of qualified specialists for the development of key sectors of the economy.

## ■ DISCUSSION

The role of the state in the development of the structure of training of specialists that would meet the needs of the country in stimulating the training of specialists of one or another profile, the tools of state support for training in relevant specialties, the effectiveness of such mechanisms, the specifics of financing the higher education system and financing the training of specialists with higher education, all these issues are reflected in studies not only by Ukrainian scientists, but by researchers from all over the world. V. Cherneha (2023) analysed the dynamics of quantitative indicators of the higher education system of Ukraine, both indicators of the number of institutions and applicants for education, and the dynamics of state funding, considered the reasons for structural changes in educational institutions of different levels, among which the decline in the prestige of groups of professions was also determined.

S. Londar (2021) examined the specifics of financing different levels of education in Ukraine, namely, secondary, vocational, vocational pre-primary, higher education, including in terms of the ratio of budget expenditures between different levels of education, confirming that a significant share of education expenditures is directed to higher education in Ukraine. The question of the existing imbalances in the distribution of places financed by the

state order, the presence of significant differences in the quality of training of specialists, a significant dispersion in the use of budget funds, the spread of a negative image regarding the quality of training in Ukraine due to the presence of facts of poor quality of training of applicants for education who studied at the expense of individuals and legal entities, all this remained out of the researcher's attention.

Exploring the structure of investments in physical and human capital, W. Paczos *et al.* (2023) insist on the expediency of changing approaches to the interpretation and classification of financial investments in education as an important component of human capital. The researchers examined the impact of reducing public spending on education and human capital in general on various countries of the European Union, and recommended the introduction of an investment approach to human capital financing. It should be noted that in the development of human capital, the professional structure of specialists and the compliance of training in specialties with the strategic needs of the country are of great importance. Therefore, the issue of using a wide range of tools in popularising priority specialties requires a thorough study.

Z. Liu *et al.* (2024) analysed investment in education in various provinces of China was carried out and the impact of state funding on the development of human capital and the features of further development of innovation processes and innovation potential in the provinces of China was determined. The researchers concluded about the insufficiency of increasing funding for education to ensure innovative development in the future. The researchers insist on the need to transform the model of development of the education system and create an innovative environment, and also prove the need to introduce a differentiated approach to the development strategies of different provinces, considering their specific features and the creation of their own development strategies, and not transfer the experience of other countries. Conclusions obtained by Z. Liu *et al.* (2024) correlate with the results of this study and confirm the conclusions made by the authors about the need for a systematic approach to the transformation of the system of state financing of higher education as a component of the development of high-quality human capital. The authors of the current study suggests that the use of only one lever is insufficient, namely, regulating the volume of state orders for training specialists to regulate quantitative and qualitative indicators of training specialists in a particular speciality.

The problem of the effectiveness of investing in higher education was considered by Y. Sun *et al.* (2023). The researchers analysed the existing imbalances that are inherent in the Chinese education system, despite the relatively significant amount of state funding for education. The researchers concluded that the effectiveness of higher education can be achieved with a comprehensive approach to solving such a problem and a comprehensive transformation of the system, considering regional, industry, and other factors. The conclusions relate to the results obtained in the above study, which indicate the need to apply an integrated approach in the process of developing high-quality human capital in conditions of limited funding and the introduction of a set of measures to improve the efficiency of using budget funds for training specialists.

The problems of the presence of imbalances in the financing of training applicants, and a discriminatory approach to various HEIs on the part of the state, are considered in the paper by V. Chentsov *et al.* (2019). The researchers emphasise the need to transform approaches to financing higher education, including through the prism of the effectiveness and efficiency of such investments, and propose the introduction of an integrated approach to the development of the higher education system in Ukraine. The study by L. Yurchyshena (2021) analysed the results of applying the formula distribution of budget funds among the HEIs of Ukraine in 2020 and 2021 based on the results of institutions' activities, with a study of the impact of individual components of the formula. The researchers agree with the conclusions about the negative aspects of applying the formula in the existing version of the regulatory framework, and also focuses on the presence of a significant impact of the number of applicants for education who study under a budget order on the amount of funding, which does not always characterise the results of the HEI's activities. V. Kolpin & M. Stater (2024) examined various government policies in the higher education system, highlights how imbalances in financial support from the state affect educational institutions, the market of educational services. They also analyse the impact of changes in financial support for students through various financial instruments on their motives for choosing a speciality and institution for future study. The impact of financial incentives and policies on the popularity of strategically important professions can be analysed by comparing them with international experience and various models of education management. I. Baker (2024) examined various models of higher education funding in the UK, Germany, and France, and how these models affect university outcomes and speciality development. This correlates with the problem of financing the training of specialists at the expense of public funds, since different approaches to the distribution of funds create conditions for attracting or alienating more capable applicants. Research based on institutional policy logic shows how different funding models affect higher education outcomes.

The study by S. Laderman *et al.* (2023) examined the sources of funding for higher education in the United States, the impact of public funding on higher education systems in the United States, in particular, how reduced public investment leads to changes in the distribution of resources between universities, how it affects the structure of educational institutions, their ability to maintain the quality of education and infrastructure. Attention was paid to assessing the impact of cuts in public investment, their impact on the availability of education, educational outcomes, and changes in funding policies. The researchers analysed how state support determines the opportunities for developing educational programmes and affects the competitiveness of specialities in the education market. This study correlates with the study of the impact of changes in the financing of training in a speciality on the change in the attractiveness of such specialities, since financial resources can determine the popularity and competitiveness of certain areas of study.

Losses in human capital are reflected in the loss of a certain share of the country's national income. The

country's potential productivity is declining. The problem of imbalances in the labour market is becoming particularly acute. The problem of imbalances in the labour market of Ukraine is the gap between the demand for specialists in certain areas and the number of trained highly qualified personnel. One of the key prerequisites for the emergence of this phenomenon is the discrepancy between the educational policy and the needs of the labour market. The high demand for specialists in technical and engineering industries, which are necessary for the development of the country, is not met due to the low attractiveness of these specialities among applicants. The rapid development of certain sectors of the economy to which education does not have time to respond, labour migration and human losses as a result of military operations exacerbate this problem, which is fraught with a lack of qualified specialists in key sectors of the economy.

## ■ CONCLUSIONS

The results of clustering specialities by their level of popularity indicate the following. More than 70% of the total list, which is from 130 to 160 specialities and specialisations, depending on the year, are not very popular among applicants, since they are chosen by less than 500 people each throughout Ukraine. At the same time, 40-45% of specialities and specialisations are made up of small ones, with up to 100 people each. However, a cluster of the most popular specialities has been identified, which is 6-10% of the total number, for which from 2,000 to 7,000 applicants are enrolled. That is, 13-20 specialities of the 5<sup>th</sup> cluster receive from 40 to 50% of applicants, while 130-160 specialities of the 1<sup>st</sup> and 2<sup>nd</sup> clusters account for less than 15% of all applicants. It is revealed that the share of applicants whose training is carried out at the expense of funding for budget funds, and therefore supported by the state, is higher precisely for clusters of small specialities and amounts to more than 50%, while for a cluster of specialities with a high number of applicants, the share of state-commissioned places is on average 23.5%. Relatively large state support for small specialities did not significantly contribute to an increase in the number of applicants for these specialities. For six years, the fluctuation in the share of applicants for specialities of clusters 1 and 2 did not exceed 1%, subject to fluctuations in the share of applicants enrolled in training at the expense of the state budget in cluster specialities, from 43% to 56%.

The paper proves that the impact of changes in the volume of state orders on the attractiveness of certain specialities is heterogeneous and varies depending on the nature of the speciality and market conditions. For some areas, an increase in the state order contributes to an increase in competition points and popularity, while for other specialities, changes in funding do not significantly affect the attraction of more capable applicants. This confirms that the attractiveness of a speciality is formed under the influence of multiple factors, and not just funding. An increase or decrease in the volume of state orders for training specialists in certain specialities can only be one of the tools for influencing the development of the future structure of the labour market through the appropriate structure of training specialists. A comprehensive system of measures should be introduced to increase the

attractiveness, prospects from the standpoint of applicants and their parents, and specialities that are needed for economic recovery and development. Among the areas of prospects for further research, it is possible to determine the development of a system of measures to promote specialities that are most important for the recovery of the Ukrainian economy. It is also necessary to agree on effective mechanisms for determining the forecasted

need for specialists and create a state order in accordance with real market demands to minimise funding losses.

#### ■ ACKNOWLEDGEMENTS

None.

#### ■ CONFLICT OF INTEREST

None.

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### Володимир Пономаренко

Доктор економічних наук, професор  
Харківський національний економічний університет імені Семена Кузнеця  
61166, просп. Науки, 9А, м. Харків, Україна  
<https://orcid.org/0000-0002-9702-8469>

### Оксана Писарчук

Кандидат економічних наук, доцент  
Харківський національний економічний університет імені Семена Кузнеця  
61166, просп. Науки, 9А, м. Харків, Україна  
<https://orcid.org/0000-0001-6674-9223>

## Аналіз впливу обсягів державного замовлення на забезпеченість економіки фахівцями певних спеціальностей

■ **Анотація.** В Україні наявні диспропорції між фахом випускників закладів вищої освіти та потребами ринку, тому питання дослідження можливостей державного впливу на підвищення популярності стратегічно необхідних для розвитку країни спеціальностей через фінансування підготовки фахівців за державним замовленням є актуальним. Дослідження мало на меті визначити, як зміна обсягів державного замовлення впливає на вибір спеціальностей, конкурсні бали, а також сформулювати рекомендації щодо оптимізації державної політики у сфері фінансування спеціальностей, важливих для економічного розвитку країни. Здійснено кластеризацію спеціальностей за чисельністю вступників зарахованих на навчання, розглянуто тенденції зміни кластерів у динаміці за 2018-2023 роки, побудовано прогнозні моделі щодо зміни чисельності вступників для кожного з кластерів, а також визначено кореляційні залежності щодо впливу зміни обсягів державного замовлення на залучення здібних вступників на спеціальність. Результати кластеризації, візуалізація яких здійснена з використанням графічних методів, певною мірою визначають популярність відповідних спеціальностей та спеціалізацій серед здобувачів, а також рівень чутливості вибору вступників до впливу зовнішніх факторів. Визначено, що коливання кількості вступників, малочисельних спеціальностей відбувається у межах 1 % незважаючи на суттєві зміни частки місць із державним фінансуванням, які фінансуються за рахунок бюджетних коштів, проте в кластері спеціальностей із великою чисельністю таке коливання у межах 10 %. Практична цінність роботи полягає у можливості використання побудованих моделей для кожної спеціальності для визначення їх чутливості до впливу змін обсягів фінансування підготовки фахівців через державне замовлення, що дозволить оптимізувати розподіл фінансових ресурсів для підготовки фахівців для галузей економіки

■ **Ключові слова:** бюджетне фінансування; підготовка фахівців; кластеризація спеціальностей; диспропорції; привабливість; фінансова підтримка