“Concentration on the Ukrainian higher education services market: Institutional and financial dimensions”

AUTHORS

Nadiia Artyukhova
Anna Vorontsova
Artem Artyukhov
Yuliia Yehorova
Olena Churikanova
Sergej Vasić
Tetiana Vasylieva

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Nadiia Artyukhova (Slovakia, Ukraine), **Anna Vorontsova** (Ukraine), **Artem Artyukhov** (Ukraine, Slovakia, Poland), **Yuliia Yehorova** (Slovakia), **Olena Churikanova** (Germany), **Sergej Vasić** (Austria), **Tetiana Vasylieva** (Ukraine)

CONCENTRATION ON THE UKRAINIAN HIGHER EDUCATION SERVICES MARKET: INSTITUTIONAL AND FINANCIAL DIMENSIONS

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Nadiia Artyukhova, Ph.D., Associate Professor, University of Economics in Bratislava, Slovakia; Department of Marketing, Sumy State University, Ukraine. (Corresponding author)

Anna Vorontsova, Ph.D., Senior Researcher, Department of International Economic Relations, Sumy State University, Ukraine.

Artem Artyukhov, DSc, Associate Professor, Senior Researcher, Department of Marketing, Sumy State University, Ukraine; University of Economics in Bratislava, Slovakia; WSEI University, Poland.

Yuliia Yehorova, Ph.D., Associate Professor, Researcher, Research Institute of Trade and Sustainable Business, Faculty of Commerce, University of Economics in Bratislava, Slovakia.

Olena Churikanova, Doctor of Economics, Professor, TUBAF Digital, TU Bergakademie Freiberg, Germany.

Sergej Vasić, Ph.D. Student, MCI The Entrepreneurial School, Austria.

Tetiana Vasylieva, Dr. of Economics, Professor, Department of Financial Technologies and Entrepreneurship, Sumy State University, Ukraine.

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Abstract

During the pandemic and russia's war against Ukraine, higher education shifted to hybrid and distance learning, with some universities forced to adapt or relocate from occupied territories. This article analyzes the institutional, spatial, and financial aspects of Ukraine's higher education market (1990–2023), focusing on financial data from 2020–2023 across 24 regions and Kyiv, excluding occupied territories. The calculated results based on concentration levels and the Herfindahl-Hirschman index for the number of educational institutions, students, and postgraduate students showed that the higher education market is highly competitive, with an uneven geographical distribution between regions. The analysis of the level of concentration of financial resources among higher education institutions, calculated based on state funding, showed that the distribution of financial resources among universities is relatively even (in 2023, the 20 largest higher education institutions accumulated more than 43.5% of total state funding). The share of state resources aimed at developing the scientific potential of higher education institutions decreased for the 20 largest higher education institutions from 58% in 2020 to 55% in 2022. Non-parametric correlation analysis revealed a low correlation between the amount of general funding for higher education institutions and the amount of revenues to the special fund for research, which indicates insufficient support and prioritization of the scientific sector in the country. These conclusions can be used in implementing the reform (balancing and optimization) of the existing educational network in Ukraine, which has been actively pursued in recent years.

Keywords tertiary education, research institution, concentration, Herfindahl-Hirschman Index, region, funding, science

JEL Classification I20, I23, I25

INTRODUCTION

Ukraine's higher education system, like the rest of the country's spheres of life, has suffered serious losses and destruction as a result of the new phase of the war that russia launched against Ukraine on February 24, 2022. For two years before the outbreak of a full-scale war, the country's education sector functioned in a pandemic and restrictions related to the rapid spread of COVID-19. Prior to these events, the higher education system's agenda included reforming and implementing the provisions of the newly revised Law of Ukraine "On Higher Education" adopted in 2014, creating a system of internal and external quality assurance of higher education in line with the standards in force in the European Higher Education Area, etc. However, during the pandemic, the issues of creating a safe environment and introducing a distance learning format came to the fore. After the outbreak of full-scale armed aggression, the situation in higher education in Ukraine became even more complicated. The educational process

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has been suspended, the buildings of Ukrainian higher education institutions (HEIs) and scientific institutions (SIs) have been destroyed, and the participants of the educational process have found themselves in different circumstances, often outside Ukraine or in regions far from the war zone; some continue to be in the temporarily occupied territories. As in 2014, after the annexation of Crimea and the outbreak of hostilities in Donbas, the Ukrainian higher education system faced the issue of relocation of educational institutions to government-controlled territory. This forced the educational process to adapt to the new conditions, which also affected the network of higher education institutions.

In the spatial dimension, higher education institutions have always been important regional centers that have accumulated innovations, knowledge, resources, and opportunities. They play an important role in training qualified specialists for the labor market and developing research and innovation and are centers of social and cultural life. At the same time, the uneven distribution of higher education institutions can create an imbalance between regions, exacerbating problems in depressed areas and creating unnecessary barriers, limiting access to resources and their potential. In times of war, the transformation of the higher education network is only deepening, including the pooling of resources or mergers of educational institutions aimed at optimizing costs and improving the quality of educational services in the face of a changing market landscape. Thus, under the current circumstances, the Ukrainian higher education system is not only trying to adapt to external challenges but also uses these circumstances as an incentive for innovation and reforms aimed at providing quality, affordable, and modern education.

1. LITERATURE REVIEW

Studying the concentration of higher education institutions is an important aspect of analyzing the efficiency and accessibility of educational services. In particular, Carvalhaes et al. (2023) investigated the processes and structural changes in the higher education system in Brazil; Cheslock and Jaquette (2022) in the United States; Highman (2017) in Europe, etc., including the processes of coopetition, cooperation, and consolidation of universities (Sułkowski et al., 2020).

The researchers note that the concentration of resources and institutions is a complex process that reflects not only the internal needs of educational institutions but is also a response to demographic, socio-economic, and technological factors. In particular, in the case of Ukraine, which is at war as a result of russia's aggression, it has been found that the very role of universities in such conditions is undergoing transformation, maximizing their third mission – social responsibility aimed at supporting the community and contributing to the reconstruction of the country (Petrushenko et al., 2023; Kozmenko et al., 2023; Nikolaiev et al., 2023). Baranovskyi et al. (2024) and Koizumi and Kato (2024) note significant changes in the competitiveness of university education in the west of Ukraine, which has become a transit zone for internally displaced persons and migrants, causing structural changes in the labor market. Zozulinskyy (2024) also emphasizes the inextricable link between the financial, economic, and social consequences of the war, which deepens the imbalance in the education market.

Considerable attention in the literature is also paid to the impact of globalization on institutional changes in education. Tight (2021) analyzes how global trends, including information technology and international competition, affect national education systems and institutions. Schofer et al. (2021) examine the most relevant current trends in higher education caused by globalization, including its importance for socio-political changes in the country and its direct impact on the reorganization of economic activities. As noted by Kuzior et al. (2020) and Manfreda-Foley (2024), migration processes can also have significant social risks that require due attention from higher education institutions, as the growing mobility of labor resources affects the overall stability and social structure of countries that receive or lose these personnel.

The studies by Samusevych et al. (2021) and Djakona et al. (2021) prove the existence of a chain link between the economy, education, digitalization, and national security, which contributes to the formation of an integrated educational ecosys-

tem. In this case, the concentration of institutions is associated with increased competitiveness and adaptability to global challenges. Moreover, an increase in R&D expenditure and other indicators of scientific activity (Didenko et al., 2022) with the right public policy has the potential to contribute to the country's economic and innovative development (Gondauri et al., 2024; Dobrovolska et al., 2023a, 2023b; Gulaliyev et al., 2024), inclusive and sustainable development (Syhyda et al., 2023; Saher et al., 2021; Mujtaba et al., 2024).

Kuzior et al. (2022a) emphasize the importance of intellectualizing human capital in the context of innovative transformations, which is key to increasing the competitiveness of higher education institutions in the modern market. Yehorova and Drozd (2024) show that human capital development is a key factor in economic freedom and social stability, emphasizing the importance of investment in higher education for macroeconomic efficiency. At the same time, research in the field of human capital development emphasizes the importance of economic models for developing strategies for talent management and competence development, strengthening financial inclusion of the population in the context of globalization and technological change (Swanson & Holton, 2001; Brajkovic, 2018; Liu et al., 2024; Didenko et al., 2023; Kuzior et al., 2022b).

Researchers note that the growing role of digital technologies is changing the structure of educational services markets, contributing to the concentration of resources in the most adaptive and technologically advanced educational institutions (Dembitska et al., 2022; Shcherbachenko & Sliusarenko, 2023; Nurtayeva et al., 2024). Digitalization allows for the introduction of innovative teaching methods, such as distance learning courses, virtual laboratories, and adaptive learning platforms, which increases the efficiency and individualization of the educational process (Ogunleye et al., 2023; Akther et al., 2024). Although the digitalization of education may cause certain losses and have specific dysfunctions, in particular in terms of socialization, motivation, and control during learning (Marchuk, 2023), as well as risks in terms of transfer of innovative technologies (Novikova et al., 2022), it also creates new opportunities for improving the quality of educational services and expanding access to knowledge.

Grbić et al. (2020) and Brown (2022) focus on different models of higher education financing and their impact on the accessibility, quality, and efficiency of educational services, which is a sign of financial concentration in educational institutions. These works are important for understanding the changes in institutional configuration that occur under the influence of financial strategies. The study by Vorontsova et al. (2021) notes that investment in education is an important tool for reducing the digital divide, which is crucial in the context of the global transition to a digital economy. Kotina et al. (2020), Degtyarova et al. (2022), and Kichurchak (2022) analyze the specifics of higher education reform in Ukraine, including the impact of political reforms, military conflicts, and economic changes on the structure and financing of higher education. These studies emphasize the uniqueness of the Ukrainian experience and the challenges faced by the country on its way to integration into the European educational space. Using the examples of China (Yu et al., 2023, 2024) and European countries (Hryhorash et al., 2020), the authors demonstrate how the peculiarities of regional socio-economic development affect the distribution of financial resources for higher education, leading to an increase or decrease in educational disparities between regions.

Given the above, there is a need for a new theoretical understanding and empirical research on issues related to institutional-spatial and financial concentration in the network of higher education institutions. In this regard, the purpose of this study is to analyze the transformations in the network of higher education institutions in Ukraine by measuring the institutional-spatial (by the number of HEIs and SIs, students, and postgraduates) and financial (based on the volume of accumulated financial resources ensuring institutional stability and the institution's overall performance) components.

2. METHODOLOGY

This study is based on the official national statistics on the development of Ukraine's higher education sector, which is systematized by the State Statistics Service of Ukraine and the Ministry of Education and Science (MES) of Ukraine, in particular, ac-

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cording to the Unified State Electronic Database on Education, provided by the "Inforesource" State Enterprise. According to Ukrainian legislation, an HEI is a separate type of institution that is a legal entity of private or public law, operating under a license to conduct educational activities at certain levels of higher education, including universities, academies, institutes, and colleges (Verkhovna Rada of Ukraine, 2014).

To study the institutional and spatial network of HEIs and SIs, the data for 24 regions of Ukraine and the city of Kyiv on the number of institutions, students, and postgraduate students in them (excluding data for the temporarily occupied territory of the Autonomous Republic of Crimea, the city of Sevastopol, and part of the temporarily occupied territories in Donetsk and Luhansk regions) for 1990–2023 were systematized.

To study the concentration of financial resources, Ukrainian HEIs were chosen, using available data on state funding for 148 Ukrainian HEIs in 2020, 147 in 2021, 138 in 2022, and 134 in 2023. It is worth noting that some HEIs in Ukraine, such as Taras Shevchenko National University of Kyiv, are not covered by this analysis, as they received separate funding directly from the state budget, rather than through formulaic funding, and were not on equal competitive terms with other HEIs.

The analysis used data on the total funding of higher education institutions at the expense of consumption expenditures of the general fund of the state budget, which, according to the legislation of Ukraine (Cabinet of Ministers of Ukraine, 2019), includes three main components:

1. The amount of funding for stable operation that meets the basic needs of higher education institutions, such as staff salaries, communal services, material and technical supply, etc. It is calculated on the basis of fixed standards and is relatively stable regardless of changes in the institution's activities.

2. The amount of funding that fluctuates depending on the performance of the institution, which takes into account the productivity and achievements of universities in various areas. Key indicators that affect this amount include:

   - scale of activity (number of students, educational programs, etc.);
   - scientific achievements (volumes of research, publications, patents, grants);
   - international and regional recognition (positions in rankings, participation in international projects, partnerships);
   - student employment rates (percentage of graduates who found a job in their specialty).

3. A reserve created to cover unforeseen expenses or to deal with critical situations.

This approach to financing is aimed at balancing stability and flexibility and at encouraging higher education institutions to use resources more efficiently and improve the quality of their activities.

This study uses data on the amount of total funding for HEIs, the amount of funding for stable operation and those provided depending on the performance of the institution, as well as the amount of revenues to the special fund based on the results of scientific and technical work under international cooperation projects, under economic contracts and on the results of providing scientific services per academic staff member at the main place of work on average for the previous three calendar years.

The regional concentration of HEIs was estimated using Formula (1):

$$CR_i = \frac{Y_i}{Y_n}, \quad (1)$$

where CR is the level of concentration; Y_i is the number of HEIs in the region i; Y_n is the total number of all HEIs in the country.

The assessment of the concentration of financial resources of HEIs was carried out using Formula (2)

$$CR = \sum_{i=1}^{n} Z_i, \quad (2)$$

where Z_i is the share of the financial resources of a certain number of predecessor HEIs, where i = 5, 10, 15, 20.

The Herfindahl-Hirschman Index (HHI), which is an additional indicator of market concentration, is calculated using the following formula and can range from 0 (low concentration, high level of competition) to 1 (monopoly):

$$HHI = \sum_{k=1}^{N} (Y_i)^2, \quad (3)$$

where N is the total number of market participants.

The conformity of the input data to the normal distribution law was checked by constructing a frequency histogram and using the Shapiro-Wilk test. Given the data nonlinearity, the relationships between them were studied on the basis of Kendall's rank correlation coefficients, which is a nonparametric method of statistical analysis that measures the strength and direction of the relationship between two variables.

Mathematical calculations were performed using MS Excel and STATA/SE 11.1 software.

3. RESULTS AND DISCUSSION

3.1. General characteristics of the network of higher education institutions in Ukraine

Ukraine is one of the countries in Europe with one of the largest numbers of HEIs and, accordingly, students. Figure 1 shows the dynamics of their number for 1990–2023.

As of the 2023/24 academic year, there were officially 314 higher education institutions compared to 149 in 1990/91. The transition of Ukraine's higher education system to a market-based mechanism after independence led to an intensive growth in the number of educational institutions, which was observed until 2008/09 with a positive average annual growth rate of 5%, resulting in the number of HEIs reaching the level of 353. This year was crucial for the gradual transformation of Ukraine's higher education system, which aimed to balance the number and quality of educational institutions by strengthening competitive conditions in the market, numerous mergers and acquisitions in an overly massified educational network. It is worth noting that the number of HEIs reached its highest level in 2020/21, when it amounted to 515 (the growth rate was 83.3% compared to the previous year), after which a gradual decline was observed.

As for the number of students enrolled in higher education institutions, the demographic crisis in Ukraine has led to a shortage of potential applicants. An upward trend in the number of students was observed until the 2007/08 academic year, when, according to official statistics, more than 2.373 million people were enrolled, with an average annual growth rate of 6.1%. After that, there was a steady decline, and as of 2023/24, the number of higher education students was 1.149 million, which is slightly higher than in 1996/97. In general, while in 1990/91 there were only 17 stu-

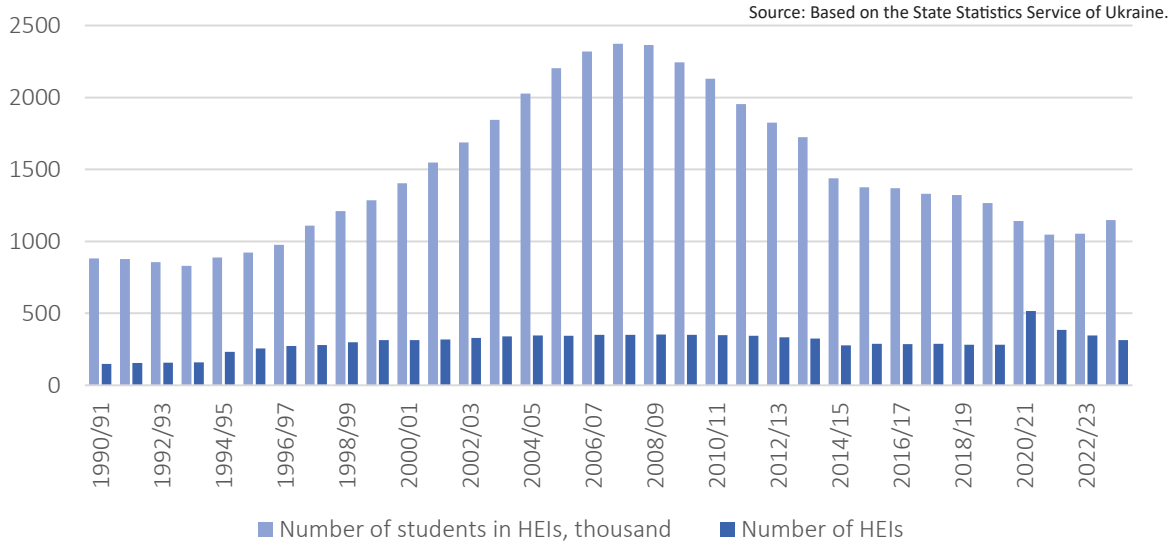

Figure 1. Dynamics of the number of HEIs and students in Ukraine for the 1990/91–2023/24 academic years

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dents per thousand of the resident population, in 2008/09 there were 50, and in 2023/24 there were only about 25.

The full-scale military invasion of Ukraine by russia, which has caused unprecedented migration, numerous destructions of educational infrastructure, and security challenges, only exacerbates this problem and calls into question the functioning of most higher education institutions in the future.

The majority of higher education institutions have postgraduate programs and thus train researchers. Figure 2 shows the changes in the number of higher education institutions with postgraduate programs and the number of postgraduate students in them for the academic years 2005/06-2023/24 (the period for which statistical information is freely available from official sources).

At the beginning of the 2005/06 academic year, there were 496 HEIs and SIs in Ukraine with postgraduate programs, the number of which grew until 2009/10 with an average annual growth rate of 1.43% to 525. After that, there was a decline, and as of the 2023/24 academic year, their number amounted to 399 institutions. The number of postgraduate students in HEIs and SIs with postgraduate programs also increased from 29.8 thousand in 2005/06 to 34.6 thousand in 2010/11, after which their number began to decline with an average annual growth rate of 4.9%. In 2020/21, the number of postgraduate students in Ukraine began to grow, and as of the beginning of 2023/24, the number of postgraduate students in Ukraine reached 46.5 thousand. In terms of coverage, at the beginning of the academic year 2023/24, there were 11 postgraduate students per 10 thousand permanent population, compared to 6 in 2005/06.

3.2. Institutional-spatial concentration among higher education institutions

The study of institutional-spatial concentration in the higher education network (Table 1), calculated using the typical indicator for determining the market structure – the concentration rate (CR), showed that the highest concentration of higher education institutions, students, and postgraduate students is observed in the city of Kyiv, Kharkiv region, and Dnipropetrovsk region, while in other regions the level of concentration of higher education institutions is much lower and varies between 2-5%. The histogram of the frequency distribution confirms the conditionally uneven geographical distribution of higher education institutions in Ukraine, which is caused by the existence of large educational centers, mainly in cities with a population of over one million (Figure 4).

Source: Based on the State Statistics Service of Ukraine.

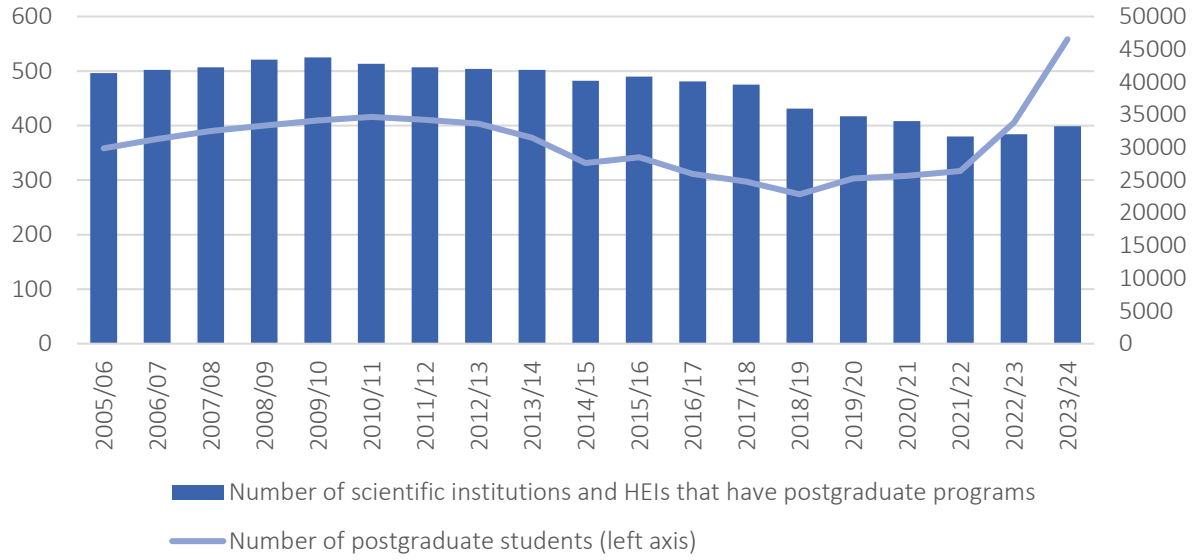

Figure 2. Dynamics of the number of research institutions and HEIs with postgraduate programs and the number of postgraduate students in Ukraine for the 2005/06–2023/24 academic years

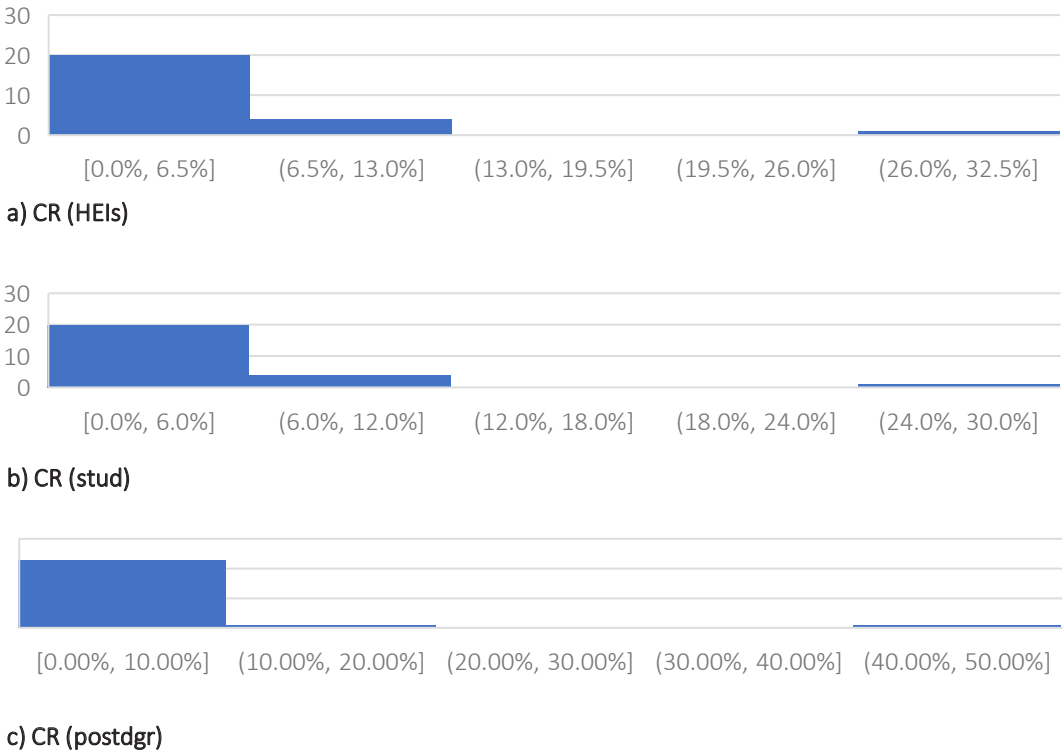

Figure 3. Histogram of frequency distribution by the indicator of institutional-spatial concentration of HEIs, students, and postgraduate students in Ukraine's regions as of the 2023/24 academic year

Compared to 2020 (pre-war period) and 2023, the following trends are worth noting. For most regions of Ukraine, there were no significant changes; only in the city of Kyiv there was an increase in the concentration of higher education institutions by 7.6%, which was due to the relocation of some educational institutions due to russia's armed aggression. The undisputed leaders in the accumulation of educational institutions for both periods are the city of Kyiv, Kharkiv region, Dnipropetrovsk region, Odesa region, and Lviv region. Comparison of concentration levels by the number of undergraduate and postgraduate students has similar trends, with the city of Kyiv showing a significant increase.

The Herfindahl-Hirschman index, which has also increased over time, indicates a low (by the number of HEIs and students) and medium (by the number of postgraduate students) level of concen-

Table 1. Levels of regional concentration by the number of HEIs and SIs in the Ukrainian educational services market for 2020/21 and 2022/23 academic years

Source: Based on the State Statistics Service of Ukraine.

Region	CR(HEIs)			CR(stud)			CR(postdgr)		
	2020	2023	Δ	2020	2023	Δ	2020	2023	Δ
Vinnytsia region	3.30	3.82	0.52	3.45	3.30	−0.15	2.30	2.01	−0.29
Volyn region	1.94	2.55	0.61	1.81	2.44	0.63	1.15	0.75	−0.40
Dnipropetrovsk region	9.90	9.24	−0.67	7.24	7.18	−0.06	5.81	6.52	0.70
Donetsk region	4.08	–	–	2.40	–	–	1.27	–	–
Zhytomyr region	2.33	1.59	−0.74	1.96	1.87	−0.09	0.86	0.75	−0.11
Zakarpattia region	1.75	2.23	0.48	1.77	1.96	0.19	2.55	1.00	−1.55
Zaporizhzhia region	3.11	3.82	0.71	4.30	4.40	0.10	3.31	2.51	−0.81
Ivano-Frankivsk region	2.52	3.18	0.66	2.82	3.19	0.37	1.95	1.25	−0.69
Kyiv region	2.33	2.23	−0.10	1.65	1.82	0.17	1.68	2.51	0.83
Kirovohrad region	1.75	2.23	0.48	1.02	1.50	0.49	0.55	1.25	0.70

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Table 1 (cont.). Levels of regional concentration by the number of HEIs and SIs in the Ukrainian educational services market for 2020/21 and 2022/23 academic years

Region	CR(HEIs)			CR(stud)			CR(postdgr)		
	2020	2023	Δ	2020	2023	Δ	2020	2023	Δ
Luhansk region	1.94	–	–	1.56	–	–	0.90	–	–
Lviv region	6.41	6.69	0.28	8.35	9.49	1.14	7.75	6.77	–0.98
Mykolaiv region	2.14	2.87	0.73	2.36	1.88	–0.48	0.79	1.50	0.72
Odesa region	6.02	6.69	0.67	6.57	6.56	–0.01	6.78	6.52	–0.27
Poltava region	2.52	2.55	0.02	2.98	3.58	0.61	2.49	2.01	–0.49
Rivne region	2.14	2.23	0.09	2.13	2.27	0.15	1.00	1.25	0.25
Sumy region	1.36	1.91	0.55	1.65	2.00	0.35	3.38	1.25	–2.13
Ternopil region	2.14	1.91	–0.23	2.48	3.31	0.83	2.15	1.50	–0.65
Kharkiv region	10.68	9.55	–1.13	10.88	10.36	–0.52	13.44	12.28	–1.16
Kherson region	2.52	–	–	1.82	–	–	1.18	–	–
Khmelnytskyi region	3.50	3.50	0.01	2.22	2.36	0.14	1.53	2.01	0.47
Cherkasy region	2.91	2.55	–0.36	2.84	2.82	–0.02	1.43	1.50	0.08
Chernivtsi region	2.14	0.96	–1.18	1.96	1.83	–0.13	1.00	0.75	–0.25
Chernihiv region	1.75	1.27	–0.47	1.14	1.39	0.25	1.28	1.25	–0.03
the city of Kyiv	18.83	26.43	7.60	22.66	24.50	1.84	33.46	42.86	9.40
HHI, unit	0.08	0.11	0.03	0.09	0.10	0.01	0.15	0.22	0.07

tration in the market, which confirms the previous data. Accordingly, there is high and moderate competition among higher education institutions, respectively.

3.3. Concentrations of financial resources among higher education institutions

In the context of studying the levels of concentration in the Ukrainian education market, another important aspect deserves attention: the distribution of financial resources of higher education institutions. Such an analysis will allow us to gain a deeper understanding of the potential and efficiency of the higher education market in the country, as funding is known to play a key role in ensuring the quality of education and research. Instead, insufficient funding may limit the ability of institutions to develop infrastructure, attract qualified professionals, and conduct quality research.

According to the legislation of Ukraine (Verkhovna Rada of Ukraine, 2014), the following resources can be used to finance HEIs:

- state budget funds, primarily based on a state order for the payment of services for training specialists, research, and teaching staff;
- funds from local budgets and local governments;
- funds of business entities and individuals;
- other sources not prohibited by the legislation of Ukraine.

As of 2021 (the last year for which data on satellite education accounts are available on the website of the State Statistics Service of Ukraine), the ratio was 77% public sector and 23% non-public sector (Figure 4). Most of the budget funding was provided by the central government and the Ministry of Education and Science, while students financed their education on a contractual basis on their own. The ratio remained similar in previous years, which demonstrates a clear indicator of the peculiarities of the distribution of funding sources for higher education.

Given the significant share of state funding of HEIs, the concentration levels of financial resources in general and by the amount of funding for the stable operations and depending on the performance of HEI were calculated (Table 2).

The obtained results indicate a low concentration of public financial resources among higher education institutions in the country, although the trend in the dynamics over the analyzed years is increasing. In particular, approximately 20 of the largest higher education institutions in 2023 have accumulated more than 43% of public funding. The Herfindahl-Hirschman index, which has

Source: Based on the State Statistics Service of Ukraine.

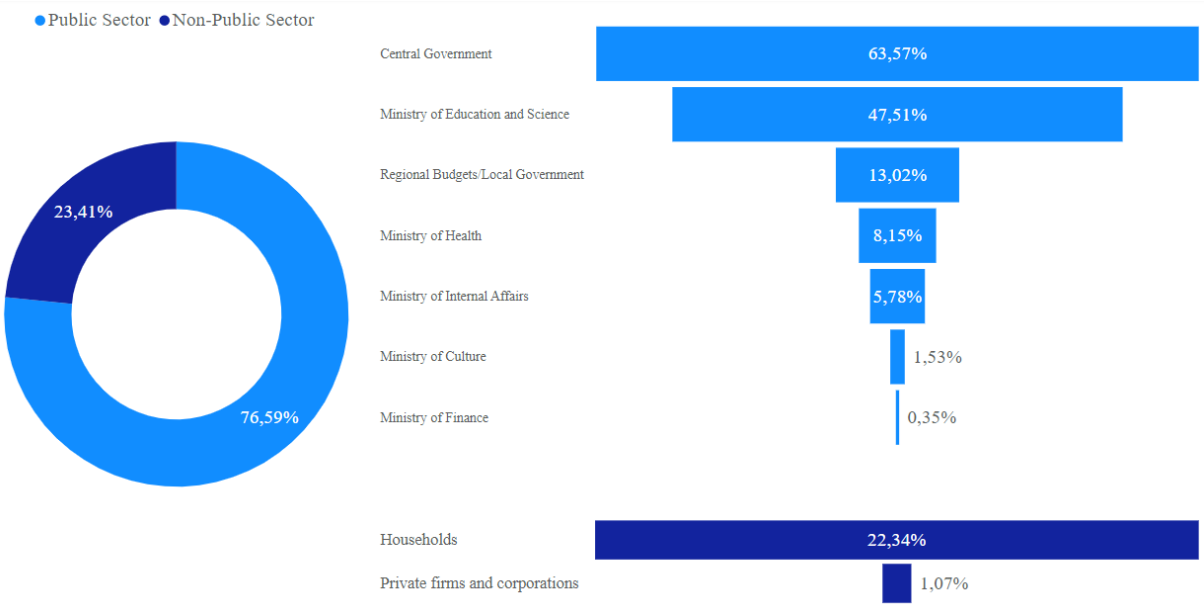

Figure 4. Ratio of financial provision of higher education in Ukraine as of 2021

Table 2. Comparison of the levels of concentration of financial resources aimed at ensuring the overall functioning of HEIs

Years	Levels of concentration of financial resources, %				HHI, units
	CR5	CR10	CR15	CR20	
by the amount of funding for HEIs					
2019	19.50	26.89	31.70	35.67	0.02
2020	20.35	28.36	33.56	37.80	0.02
2021	21.33	29.92	36.09	40.87	0.02
2022	23.13	32.73	39.40	45.31	0.02
2023	22.04	30.55	38.04	43.55	0.02
by the amount of funding for the stable operation of HEIs					
2020	19.38	26.73	31.51	35.52	0.02
2021	21.13	29.57	35.71	40.41	0.02
2022	22.72	32.17	38.85	44.78	0.02
2023	X	X	X	X	X
by the amount of funding provided depending on the performance of the HEI					
2020	23.67	34.33	41.11	46.24	0.02
2021	25.14	35.77	42.77	48.72	0.02
2022	24.71	34.90	41.57	47.45	0.02
2023	X	X	X	X	X

Note: X – no data, as the formulaic funding system was suspended after the start of the full-scale invasion to streamline funding for universities under martial law.

rather low constant values (0.02), also confirms the low concentration of financial resources in the market and indicates a high level of competition in the market.

The list of the twenty HEIs with the highest concentration of financial resources in terms of total funding in 2023 is presented in Table 3 in descending order.

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Table 3. List of the twenty HEIs with the highest concentration of financial resources in terms of total funding in 2023

Source: Based on data from the Ministry of Education and Science of Ukraine.

No.	Name of the HEI	Region of location	CR, %
1	National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"	the city of Kyiv	8.66
2	Lviv Polytechnic National University	Lviv region	4.76
3	National University of Life and Environmental Sciences of Ukraine	the city of Kyiv	3.10
4	Ivan Franko National University of Lviv	Lviv region	2.81
5	National Aviation University	the city of Kyiv	2.70
6	National Technical University "Kharkiv Polytechnic Institute"	Kharkiv region	2.45
7	Kyiv National University of Culture and Arts	the city of Kyiv	2.30
8	V.N. Karazin Kharkiv National University	Kharkiv region	1.83
9	Kharkiv National University of Radio Electronics	Kharkiv region	1.49
10	National Aerospace University named after M.E. Zhukovsky "Kharkiv Aviation Institute"	Kharkiv region	1.48
11	Kyiv National University of Construction and Architecture	the city of Kyiv	1.40
12	Zaporizhzhya Polytechnic National University	Zaporizhzhya region	1.28
13	Yuriy Fedkovych Chernivtsi National University	Chernivtsi region	1.26
14	Sumy State University	Sumy region	1.26
15	Yaroslav Mudryi National Law University	Kharkiv region	1.25
16	State Biotechnological University	Kharkiv region	1.22
17	Uzhhorod National University	Zakarpattia region	1.21
18	Odesa National Polytechnic University	Odesa region	1.16
19	Oles Honchar Dnipro National University	Dnipropetrovsk region	1.12
20	Dnipro University of Technology	Dnipropetrovsk region	1.10

The largest amount of funds was allocated to the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" and Lviv Polytechnic National University, which were also the leaders in the previous two years (2020-2022). The geographical structure of the list includes higher education institutions from the city of Kyiv, Kharkiv region, Lviv region, and Dnipropetrovsk region. Individual institutions are represented from Sumy region (Sumy State University), Odesa region (Odesa *National* Polytechnic *University*), Chernivtsi region (Yuriy Fedkovych Chernivtsi National University), and Zakarpattia region (Uzhhorod National University).

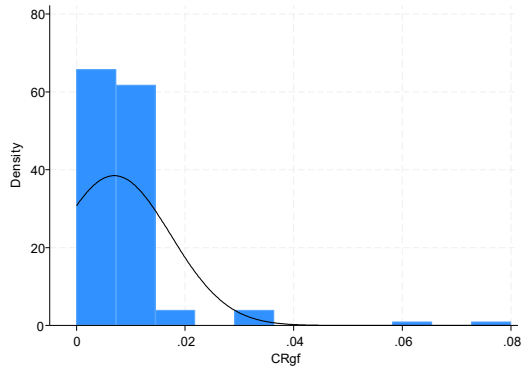
According to the legislation of Ukraine, the amount of funding based on the results of the HEI's activities includes the scientific component, in particular, the section on the amount of revenues to the special fund based on the results of scientific and scientific and technical works under international cooperation projects, under economic contracts, and on the results of the provision of scientific services per one research and teaching staff member at the main place of work on average for the previous three calendar years. Table 4 shows the levels of concentration of financial resources aimed at strengthening the scientific potential of HEIs for the first five, ten, etc. HEIs for the years available in the public domain.

Table 4. Comparison of levels of concentration of financial resources aimed at developing the scientific potential of HEIs

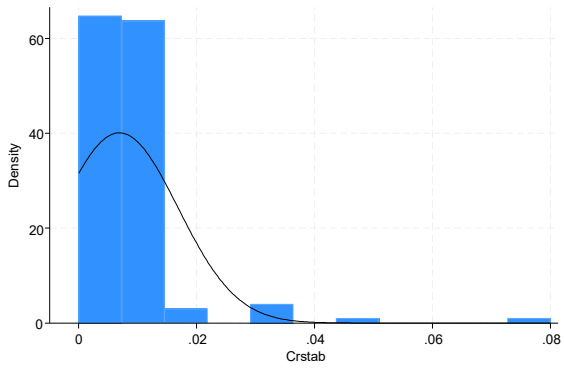
Years	Levels of concentration of financial resources, %				HHI, units
	CR5	CR10	CR15	CR20	
2020	25.75	40.19	50.62	58.44	0.02
2021	23.23	38.13	48.68	57.33	0.02
2022	21.07	36.20	46.78	55.40	0.02

The results show that the levels of concentration of financial resources for the leading educational institutions in the market are only decreasing over the analyzed period, and in general, there is a low concentration of financial resources aimed at developing the scientific potential of HEIs.

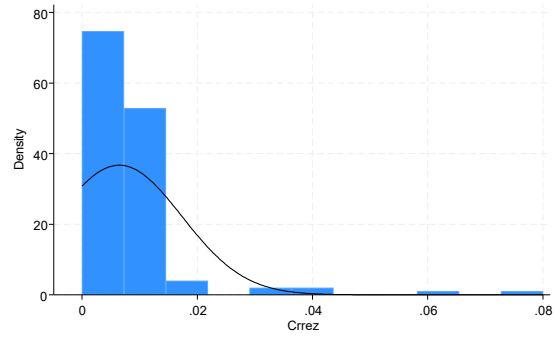
Next, the relationships between the previously calculated concentration levels were studied. First, let us examine their compliance with the normal distribution law. As can be seen from Figure 5, the selected indicators are not normally distributed. This is confirmed by the calculation of the Shapiro-Wilk test (Appendix A).



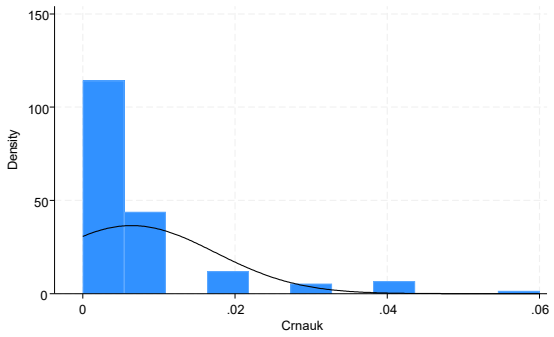
a) the amount of total funding for HEI (*CRgf*)



b) the amount of funding for the stable operation of HEI (*CRst*)



c) the amount of funding provided depending on the performance of the HEI (*CRrz*)



d) the amount of revenues to the special fund for research areas of HEI (*CRscf*)

Figure 5. Verification of compliance with the normal law of distribution of indicators of concentration of the Ukrainian higher education market

The next step is to build a correlation matrix (Table 5) using Kendall's rank correlation coefficients, which assess the strength of the links between specific levels of financial resource concentration among higher education institutions, as well as the actual and estimated applicants.

The results show a very high positive correlation between the amount of general funding for higher education institutions, as well as funding for stable activities and funding provided depending on the performance of the institution. At the same time, the correlation coefficient with the amount

Table 5. Correlation matrix between the calculated levels of concentration of financial resources of HEIs and their applicants

Variable	*CRgf*	*CRst*	*CRrz*	*CRscf*	*Apl_fact*	*Apl_pl*
CRgf	1.00	–	–	–	–	–
	–					
CRst	0.96	1.00	–	–	–	–
	0.00	–				
CRrz	0.79	0.75	1.00	–	–	–
	0.00	0.00	–			
CRscf	0.26	0.26	0.37	1.00	–	–
	0.00	0.00	0.00	–		
Apl_fact	0.70	0.68	0.71	0.18	1.00	–
	0.00	0.00	0.00	0.01	–	
Apl_pl	0.73	0.70	0.74	0.22	0.88	1.00
	0.00	0.00	0.00	0.00	0.00	–

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of revenues to the special fund for the scientific direction of the HEI is rather low. This indicates that despite the importance of the scientific potential of HEIs, its results have not had a sufficient impact on the distribution of funding for HEIs in Ukraine. Both the calculated and the actual number of applicants for higher education enrolled based on state order have a fairly close relationship with funding indicators, except for the amount of revenues in the scientific field.

The analysis of institutional and financial concentration in the education market allows to identify key trends and challenges that are important for understanding the dynamics of this sector. The above results of the study of changes in institutional and financial concentration in the market correlate with the findings of Vieira and Lepori (2016), who studied the dynamics of growth in the size of HEIs. In contrast to the current study, Vieira and Lepori (2016) measured concentration by the number of academic staff, focusing on the fact that the cumulative effects of growth and reputation contribute to the concentration of resources in large and highly reputable HEIs, which can lead to a widening gap between large and small institutions.

This study is also consistent with the work of Hemsley-Brown (2017), who studied the structure of the higher education system and its direct segmentation by various characteristics, while highlighting the risks of segmentation. At the same time, the current study focuses mainly on the implications of market concentration for the management of the higher education sector while Hemsley-Brown emphasizes that market segmentation allows identification of the diversity of needs and expectations of the student audience while causing a number of ethical dilemmas. In particular, the emphasis is placed on the fact that segmentation based on socio-economic, religious, or ethnic criteria can lead to injustice and unequal access to higher education.

The findings that there is no correlation in Ukraine between the level of concentration of financial resources in universities and their research performance and the suggestions that the diversity of university activities should be taken into account through coefficients in the funding formula are consistent with Roessler and Catacutan (2020), who also emphasize the importance of each university mission – teaching, research, international cooperation, and participation in supporting local communities.

This study is also consistent with the findings of Degtyarova et al. (2018), who identify the main problems of the current system of financing higher education in Ukraine as its centralization, dependence on the state budget, and shortcomings in the distribution of state orders for training. At the same time, our study emphasizes the underestimation of funding for the scientific potential of educational institutions, while Degtyarova et al. (2018) focus on unequal conditions of competition between leading and regional universities.

CONCLUSIONS

Within the framework of the aim of this paper to analyze transformations in the network of higher education institutions of Ukraine by measuring institutional-spatial and financial components, a data set was formed, including quantitative indicators of the functioning of the higher education market in Ukraine (in particular, the number of higher education institutions and research institutions, the number of students and postgraduates in them, and the amount of funding for higher education institutions in different categories) for 24 regions of Ukraine and the city of Kyiv, respectively, and functioning higher education institutions for 2020–2023.

The analysis of the general trends in Ukraine's higher education sector showed that the country is experiencing a tendency to reform the existing educational network by balancing and optimizing it, which has led to a partial reduction in the number of HEIs and SIs. As for the number of students, due to the demographic crisis and geopolitical factors, their number has also experienced a significant decline. However, the number of postgraduate students has been increasing in recent years.

The level of regional concentration and the Herfindahl-Hirschman index calculated on the basis of these indicators showed that the higher education market is highly competitive, while a certain uneven geographical distribution of higher education institutions in Ukraine was revealed. In particular, the highest concentration of HEIs and SIs is observed in the city of Kyiv, Kharkiv region, Dnipropetrovsk region, Odesa region, and Lviv region.

A more in-depth study of the concentration of financial resources of HEIs revealed that as of 2023, the 20 largest higher education institutions in terms of funding accumulate more than 43.5% of total state funding, which indicates a low level of financial concentration among higher education institutions, although in the time dynamics (2020–2023), the level of overall concentration has gradually increased. Over the past 4 years, the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" and Lviv Polytechnic National University have remained the leaders in terms of funding. At the same time, the amount of funds allocated for developing the scientific potential of higher education institutions in 2020–2022 for the top 20 universities decreased slightly, which indicates changes in the priorities of state educational policy under martial law.

The non-parametric correlation analysis revealed that the correlation between the amount of total funding for HEIs and the amount of revenues to the special fund for research is quite low. This may indicate a problem in the allocation of HEI resources, where a significant portion of funds may be spent on other needs, such as infrastructure, administrative costs, or general operating expenses, leaving less money for research and development. The findings can serve as a basis for developing strategies and policies at the level of the state and individual higher education institutions aimed at optimizing the allocation of financial resources in higher education.

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AUTHOR CONTRIBUTIONS

Conceptualization: Nadiia Artyukhova.
Data curation: Nadiia Artyukhova.
Formal analysis: Nadiia Artyukhova.
Funding acquisition: Yuliia Yehorova.
Investigation: Nadiia Artyukhova.
Methodology: Nadiia Artyukhova.
Project administration: Tetiana Vasylieva, Artem Artyukhov.
Software: Nadiia Artyukhova, Olena Churikanova, Sergej Vasić.
Supervision: Artem Artyukhov, Tetiana Vasylieva.
Validation: Nadiia Artyukhova.
Visualization: Nadiia Artyukhova, Yuliia Yehorova, Olena Churikanova, Sergej Vasić.
Writing – original draft: Nadiia Artyukhova, Anna Vorontsova, Artem Artyukhov, Yuliia Yehorova, Olena Churikanova, Sergej Vasić, Tetiana Vasylieva.
Writing – review & editing: Nadiia Artyukhova, Anna Vorontsova, Artem Artyukhov, Yuliia Yehorova, Olena Churikanova, Sergej Vasić, Tetiana Vasylieva.

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APPENDIX A

Table A1. Results of using the Shapiro-Wilk criterion for the input data to check compliance with the normal distribution law of the selected indicators of higher education market concentration

Variable	Obs	W	V	z	Prob>z
CRgf	138	0.72595	29.694	7.654	0.00000
CRst	138	0.73776	28.414	7.554	0.00000
CRrz	138	0.72062	30.271	7.697	0.00000
CRscf	138	0.83780	17.575	6.470	0.00000
Apl_fact	138	0.65946	36.897	8.144	0.00000
Apl_pl	138	0.65576	37.298	8.168	0.00000

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