Економіко-математичні методи та моделі фінансового розвитку

Economic and mathematical methods and models of financial development

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"Golden Intersection" in performance indicators of higher education institutions of Ukraine

Abstract. The domestic system of higher education is obliged to ensure quality, transparency and mobility. The purpose of the article is to identify the "golden intersection" in the indicators of the quality of the provision of educational-scientific services by higher education institutions (HEIs) of Ukraine based on automated ABC analysis. The methodology for conducting automated ABC analysis using the Microsoft Excel spreadsheet processor has been developed; an ABC analysis of the quality indicators of the provision of educational and scientific services by HEIs of Ukraine was carried out in terms of the total number of prepared prize winners of the All-Ukrainian student olympiad and the All-Ukrainian contest of student scientific works; the hypothesis about the existence of a "golden intersection" in quality indicators of the provision of educational and scientific services by HEIs of Ukraine was tested.

Group A included 84 HEIs of Ukraine (38.53% of the total number), which had from 15 to 146 prize winners. The accumulated share of prize winners of this group of HEIs in their total number was 80.97%. Group B included 56 HEIs of Ukraine (25.69% of the total number), which had from 7 to 14 prize winners. Their contribution to the total number of prize winners was 14.19%. Group C included 78 HEIs of Ukraine (35.78% of the total number) with the number of prize winners from 1 to 6. The share of graduates from HEIs of this group in the total number was 4.84%.

In order to test the hypothesis of the existence of a "golden intersection", it was assumed that HEIs from groups B and C would have a larger value, HEIs from group A would have a smaller value. The ratio of 134/84 HEIs was obtained. The calculated values turned out to be extremely close to the reference "golden" number φ=1.618.

Keywords: *higher education institutions of Ukraine, financing, educational and scientific services, quality of educational and scientific services, prize winners, All-Ukrainian student olympiad, All-Ukrainian competition of student scientific works, ABC analysis, "golden intersection", automation*.

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Introduction. In December 2019, the Decree of the Cabinet of Ministers of Ukraine approved the formula for the distribution of state budget expenditures on higher education among higher education institutions (HEIs). According to this formula, the state customer allocates for the corresponding year the consumption expenses of the general fund of the state budget for the training under the conditions of the state order of junior bachelors, bachelors, specialists, masters, post-graduate students and doctoral students between HEIs belonging to the sphere of management of the state customer, as well as separate structural divisions such HEIs operating in accordance with the regulations approved in the established order, have a separately defined licensed volume and directly train students of higher education under the conditions of a state order. Please note that this formula does not finance higher military educational institutions (HEIs with specific study conditions) and military educational units of HEIs [1].

The comprehensive indicator of the activity of the i-th state-owned HEI (Ai), on the basis of which the amount of funding is determined, is calculated according to the following formula:

$$A_i=EC_i\times S_i\times RS_i\times SA_i\times IR_i\times EG_{i,} \quad (1)$$

where ECi – the estimated contingent of higher education applicants who study under the conditions of a state order;

Si – an indicator of the scale of activity;

RSi – an indicator of regional support;

SAi – an indicator of scientific activity;

IRi – an indicator of international recognition;

EGi – an indicator of employment of graduates [1].

From the point of view of the Ministry of Education and Science (MES) of Ukraine, each of the components of the formula is a certain incentive. This is shown in more detail in Figure 1.

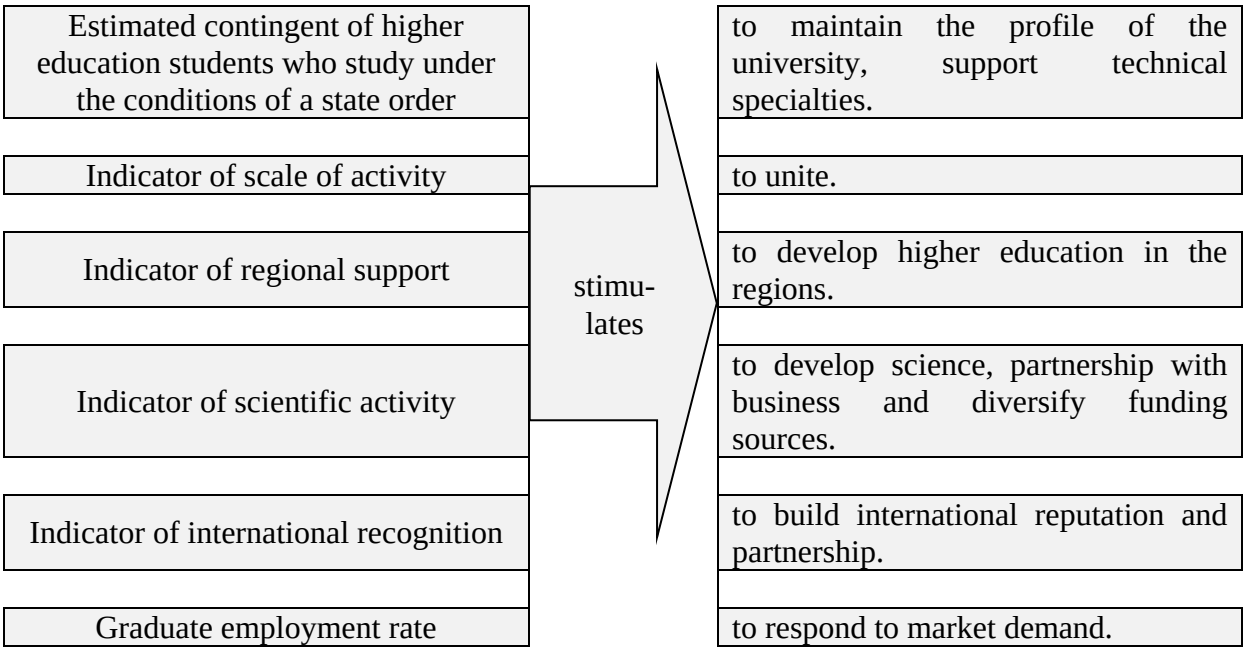

Figure 1. Stimulating the activities of domestic HEIs
Source: concluded on the basis of [8].

As you can see, among the proposed indicators, there is no one that would take into account the quality of providing educational and scientific services to students of higher education.

Ukraine is a member of the European Higher Education Area (EHEA). In the Rome Ministerial Communiqué stated: “EHEA is a unique cooperation built on trust, where public

authorities and higher education stakeholders work together to define and achieve shared goals. Thanks to the diversity of our cultures, languages and environments, and to our shared *commitment to quality*, transparency and mobility, our higher education systems offer *unequalled opportunities for learning*, teaching, *research* and innovation" [9]. Therefore, we consider it expedient to take into account indicators of the quality of the provision of educational and scientific services when determining the amount of funding of state HEIs. In this way, there will be a simultaneous increase in the efficiency of work in three strategic areas of modernization of the higher education management system: educational-social, scientific-innovative, and financial-investment [16, 298].

In our opinion, the number of prize-winners of the All-Ukrainian student olympiad in educational disciplines and specialties (specializations), as well as the number of prize-winners of the All-Ukrainian competition of student scientific works in fields of knowledge and specialties, can be attributed to the indicators of the quality of the provision of educational and scientific services. Information about them is available on the website of the Institute for the modernization of the content of education. To group HEIs of Ukraine according to the level of prize-winning students, you can apply the ABC analysis, which is popular in management practice, and already on its basis – the "golden intersection".

Literature review. Modern scientific thought uses the method of ABC analysis mainly in the field of enterprise inventory management and pharmacotherapy. However, in higher education, it has been used to: D. Carlucci et al. – support teaching and course quality assessment [2]; L. M. Hanushchak-Efimenko et al. – ranking of university autonomy program components according to various parameters [4]; O. L. Totska – analysis of income from the admission campaign of HEIs [15; 17–18], analysis of the results of the All-Ukrainian student olympiad [16, 489–493], monitoring the development of entrepreneurial activities of Ukrainian HEIs in the scientific field [19]; R. A. Slav'yuk & O. L. Totska – analysis of the amount of income to the special fund of HEIs of Ukraine based on the results of scientific and scientific-technical works under international cooperation projects, economic contracts and the provision of scientific services [12].

As for the "golden intersection", it is mentioned mostly in publications of an artistic or mathematical direction. Although in the field of education, the following articles can be singled out: V. Yu. Inozemtseva – the passing of the "golden intersection" between the real needs of the individual and educational programs is determined [5]; B. Kaygin et al. – investigated the impact of teaching Fibonacci numbers and the "golden intersection" in integration with the history of mathematics on student achievement [6].

Scientists have also devoted a number of works to the study of the quality of education in different countries of the world: S. Grant et al. – teachers' reports on the creation of a quality improvement plan in Australia [3]; N. P. Manea & M. Iatagan – Romanian postgraduate students' perception of the quality of higher education services [7]; R. O. Pavliuk et al. – peculiarities of measuring the quality of educational services in the higher education system of Ukraine through student evaluations [11]; M. P. Trifonova – the quality of education and care in kindergartens and their readiness for inclusive education in Bulgaria [20]; C. Zafiropoulos & V. Vrana – perception of the quality of educational services by both students and employees of the Institute of higher education in Greece [21], etc.

The lack of publications that combine the automated use of the ABC analysis method and the "golden intersection" for the field of higher education substantiates the relevance and originality of the proposed research.

Purpose, objectives and research methods. The purpose of the article is to identify the "golden intersection" in the quality indicators of the provision of educational and scientific services of HEIs of Ukraine on the basis of automated ABC analysis. For its implementation, the following tasks were set and completed:

1) to develop a methodology for conducting an automated ABC analysis using a Microsoft Excel spreadsheet;

2) to conduct an ABC analysis of the indicators of the quality of the provision of educational and scientific services of HEIs of Ukraine in terms of the total number of prepared prize-winners of the All-Ukrainian student olympiad and the All-Ukrainian competition of student scientific works;

3) on the basis of the obtained results, to test the hypothesis about the existence of a "golden intersection" in the quality indicators of the provision of educational and scientific services of HEIs of Ukraine.

The research methodology consists in conducting an ABC analysis of the quality indicators of the provision of educational and scientific services of HEIs of Ukraine for 2018/2019 and testing the hypothesis about the presence of a "golden intersection" in the obtained results. Note that this period was chosen for analysis due to the fact that in 2019/2020 the II stage of the All-Ukrainian student olympiad in academic disciplines and specialties (specializations) did not take place due to the pandemic; in 2021/2022 2-nd round of the All-Ukrainian competition of student scientific papers in the fields of knowledge and specialties was canceled due to the martial law. They are not being held even now because of military operations on the territory of Ukraine. The research software is a Microsoft Excel spreadsheet.

Research results. ABC analysis is a method of classifying subjects or activities according to their relative importance. It is also known as "separating the vital few from the trivial many" because, for any group of things that contribute to an overall effect, relatively few contributors account for most of the effects [10].

So, ABC analysis divides the initial set of objects into three subsets depending on their specific weight in the overall value of a certain indicator: A – about 75–80%, B – about 10–15%, C – about 5–10%. It is based on the Pareto principle, according to which 20% of the causes cause 80% of the effects. Most often, this method is used in the field of inventory management.

The "golden intersection" is formed by two quantities (x) and (y), if the ratio (φ) of their sum to the larger quantity is equal to the ratio of the larger to the smaller:

$$\varphi=(x+y)/x=x/y, \quad (2)$$

where x – a larger value;

y – a smaller value.

Note that this ratio is considered the most appropriate aesthetic perception of the image, and the number φ=1.618... is sometimes called "gold". Therefore, it is not surprising that the "golden intersection" is common in architecture and art.

According to the results of the All-Ukrainian student olympiad in academic disciplines and specialties (specializations) and the results of the All-Ukrainian competition of student scientific papers in fields of knowledge and specialties in 2018/2019 year, the prize-winners represented 218 HEIs of Ukraine (both state, subordinated to various institutions, and private): universities, academies, institutes, colleges. In total, they received 3,967 diplomas: 1,638 diplomas of the 1st, 2nd, and 3rd degrees for winning places in the olympiad; 2,329 diplomas of I, II, III degrees for prizes in the competition [13–14].

During the ABC analysis, HEIs of Ukraine will be divided into the following three groups:

A – about 80% – HEIs with a large number of prize-winning students of the All-Ukrainian student olympiad and the All-Ukrainian competition of student scientific works and, accordingly, high quality of the provision of educational and scientific services for their preparation;

B – about 15% – HEIs with an average number of prize-winning students;

C – about 5% – HEIs with a small number of prize-winning students.

When testing the hypothesis about the presence of a "golden intersection" in the indicators of the quality of the provision of educational and scientific services of HEIs of Ukraine based on ABC analysis, we will assume that the higher value (x) will be HEIs from groups B and C, the lower value (y) will be HEIs from group A.

We will conduct an automated ABC analysis with the help of a Microsoft Excel spreadsheet based on the summarizing indicator of the prize winners for each HEI according to the following algorithm:

1) let's create an electronic form of a table for ABC analysis on a Microsoft Excel sheet in cells **B2:I221**. A fragment of the table is shown in Figure 2;

2) fill in column **B** as follows: in cells **B1:B220**, enter serial numbers from 1 to 218; in cell **B221**, enter the word "Together";

3) let's fill in column **C** with the names of HEIs of Ukraine that had prize winners of the olympiad and/or competition;

4) in column **D** for each HEI of Ukraine, enter the number of olympiad prize-winners (if available);

5) in column **E** for each HEI of Ukraine, enter the number of prize winners of the competition (if available);

6) fill in column **F** as follows: in cell **F3**, enter the formula **=D3+E3** – to calculate the total number of winners for the first HEI; copy this formula into cells **F4:F220** – to calculate the total number of prize winners for other HEIs;

7) fill in column **G** as follows: in cell **G3**, enter the formula **=F3/F221*100** – to calculate the share of prize winners of the first HEI in their total number; copy this formula into cells **G4:G220** – to calculate the share of prize winners of other HEIs in their total number;

8) fill in the final line **221** as follows: in cell **D221**, enter the formula **=SUM(D3:D220)** – to calculate the total number of prize winners of the olympiad in Ukraine; in cell **E221**, enter the formula **=SUM(E3:E220)** – to calculate the total number of prize winners of the competition in Ukraine; in cell **F221**, enter the formula **=SUM(F3:F220)** – to calculate the total number of olympiad prize-winners and competition prize-winners in Ukraine; in cell **G221**, enter the formula **=SUM(G3:G220)** – to calculate the total sum of the shares of olympiad prize-winners and competition prize-winners in their total number in Ukraine (it must be equal to 100);

9) sort the HEIs of Ukraine in descending order of the share of olympiad and competition winners in the total number to obtain their unique rating by this indicator: select cells **C3:G220** → *Main* → *Sorting and filter* → *Customizable sorting* → in the *"Sort by"* field let's indicate "The share of prize-winners in the total quantity, %" → in the *"Order"* field, specify "Descending" → *OK*;

10) fill in column **H** as follows: in cell **H3**, enter the formula **=G3** – to calculate the share of prize winners of the first HEI in their total number; in cell **H4**, enter the formula **=H3+G4** – to calculate the accumulated share of prize winners of the first and second HEIs in their total number; let's copy this formula into cells **H5:H220** – to gradually calculate the accumulated share of the prize-winners following in the order of HEIs in their total number;

11) fill in column **I** as follows: in cell **I3**, enter the formula **=IF(H3<81;"A";IF(H3<95.2;"B";"C"))** – to set for the first HEI the group, in which it falls according to the ABC analysis; copy this formula into cells **I4:I220** – to set for other HEIs the group into which they fall according to the ABC analysis;

12) color the rows of the table in three colors, depending on the symbols in the cells of column **I** (green – for the HEIs from group A, yellow – for the HEIs from group B, red – for the HEIs from group C).

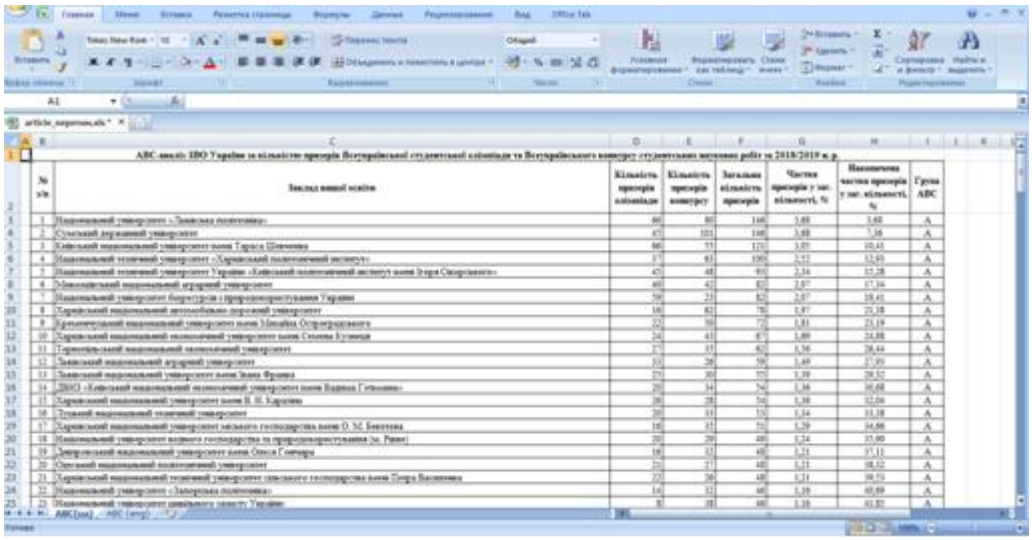

Figure 2. A fragment of the electronic form of the table for ABC analysis
Source: author's development

The obtained results of the ABC analysis are displayed in the Tables 1–3.

Table 1. HEIs of Ukraine according to the results of the ABC analysis (group A)

No	Higher education institution	The number of olympiad prize-winners	The number of prize-winners of the competition	Total number of prize-winners	The share of prize-winners in the total quantity, %	The accumulated share of prize-winners in the total quantity, %	ABC group
1	Lviv Polytechnic NU	66	80	146	3.68	3.68	A
2	Sumy SU	45	101	146	3.68	7.36	A
3	Taras Shevchenko NU of Kyiv	66	55	121	3.05	10.41	A
4	NTU "Kharkiv Polytechnic Institute"	37	63	100	2.52	12.93	A
5	NTU of Ukraine "Ihor Sikorsky Kyiv Polytechnic Institute"	45	48	93	2.34	15.28	A
6	Mykolaiv NAU	40	42	82	2.07	17.34	A
7	NU of Bioresources and Nature Management of Ukraine	59	23	82	2.07	19.41	A
8	Kharkiv National Automobile and Highway University	16	62	78	1.97	21.38	A
9	Kremenchug Mykhailo Ostrogradskyi NU	22	50	72	1.81	23.19	A
10	Simon Kuznets Kharkiv NEU	24	43	67	1.69	24.88	A
11	Ternopil NEU	27	35	62	1.56	26.44	A
12	Lviv NAU	33	26	59	1.49	27.93	A
13	Ivan Franko NU of Lviv	25	30	55	1.39	29.32	A
14	Kyiv NEU named after Vadym Hetman	20	34	54	1.36	30.68	A
15	V. N. Karazin Kharkiv NU	26	28	54	1.36	32.04	A
16	Lutsk NTU	20	33	53	1.34	33.38	A
17	O. M. Beketov NU of Urban Economy in Kharkiv	16	35	51	1.29	34.66	A
18	NU of Water Management and Nature Resources Use	20	29	49	1.24	35.90	A
19	Oles Honchar Dnipro NU	16	32	48	1.21	37.11	A
20	Odesa National Polytechnic University	21	27	48	1.21	38.32	A
21	Kharkiv Petro Vasylenko NTU of Agriculture	22	26	48	1.21	39.53	A
22	Zaporizhia Polytechnic NU	14	32	46	1.16	40.69	A

23	NU of Civil Defense of Ukraine	8	38	46	1.16	41.85	A
24	Vinnytsia Mykhailo Kotsyubynskyi SPU	16	26	42	1.06	42.90	A
25	Zaporizhzhia NU	10	29	39	0.98	43.89	A
26	NU of Food Technologies	19	20	39	0.98	44.87	A
27	Tavria State Agrotechnological University	29	10	39	0.98	45.85	A
28	Kharkiv NU of Radio Electronics	19	20	39	0.98	46.84	A
29	Kyiv NTEU	12	26	38	0.96	47.79	A
30	Kyiv NU of Technologies and Design	8	30	38	0.96	48.75	A
31	Odesa NA of Food Technologies	20	17	37	0.93	49.68	A
32	Poltava NTU named after Yury Kondratyuk	9	28	37	0.93	50.62	A
33	National Aviation University	15	20	35	0.88	51.50	A
34	Kherson SU	5	29	34	0.86	52.36	A
35	Vasyl' Stus Donetsk NU	12	21	33	0.83	53.19	A
36	Bogomolets NMU	25	8	33	0.83	54.02	A
37	Kryvyi Rih NU	2	30	32	0.81	54.83	A
38	Zhytomyr Polytechnic SU		32	32	0.81	55.63	A
39	National Pedagogical Drahomanov University	20	12	32	0.81	56.44	A
40	Kharkiv NU of Construction and Architecture	5	26	31	0.78	57.22	A
41	Pryazovsky STU	10	20	30	0.76	57.98	A
42	Yury Fedkovich Chernivtsi NU	12	18	30	0.76	58.73	A
43	Vinnytsia NTU	9	20	29	0.73	59.47	A
44	Lviv SU of Life Safety	9	20	29	0.73	60.20	A
45	National Aerospace University named after M. E. Zhukovsky "Kharkiv Aviation Institute"	21	8	29	0.73	60.93	A
46	Sumy NAU	8	21	29	0.73	61.66	A
47	Ukrainian Engineering Pedagogics Academy	7	21	28	0.71	62.36	A
48	Pavlo Tychyna Uman SPU	9	19	28	0.71	63.07	A
49	Khmelnytskyi NU	11	17	28	0.71	63.78	A
50	Vasyl Stefanyk Prekarpathian NU	10	15	25	0.63	64.41	A
51	NU "Odesa Law Academy"	5	20	25	0.63	65.04	A
52	Poltava V. G. Korolenko NPU	13	11	24	0.60	65.64	A
53	Admiral Makarov NU of Shipbuilding	3	20	23	0.58	66.22	A
54	Kharkiv NAU named after V. V. Dokuchaev	15	8	23	0.58	66.80	A
55	Central Ukrainian NTU	14	9	23	0.58	67.38	A
56	Ivano-Frankivsk NTU of Oil and Gas	13	9	22	0.55	67.94	A
57	National Metallurgical Academy of Ukraine	7	15	22	0.55	68.49	A
58	Poltava State Agrarian Academy	6	16	22	0.55	69.04	A
59	Ukrainian Medical Stomatological Academy	17	5	22	0.55	69.60	A
60	Ukrainian SU of Railway Transport	3	19	22	0.55	70.15	A
61	Vinnytsia NAU	18	3	21	0.53	70.68	A
62	Drohobytch Ivan Franko SPU	7	14	21	0.53	71.21	A
63	I. Gorbachevsky Ternopil NMU	19	2	21	0.53	71.74	A
64	Bukovinian SMU	12	8	20	0.50	72.25	A
65	Pereyaslav-Khmelnytskyi SPU named after Hryhoriy Skovoroda	7	13	20	0.50	72.75	A
66	Dnipro STU	7	13	20	0.50	73.25	A
67	Borys Grinchenko Kyiv University	3	17	20	0.50	73.76	A
68	Sumy SPU named after A. S. Makarenko	6	13	19	0.48	74.24	A
69	Kharkiv SU of Food Technology and Trade	6	13	19	0.48	74.72	A
70	Berdyansk SPU	8	10	18	0.45	75.17	A
71	Banking University	13	5	18	0.45	75.62	A
72	Dnipro State Agrarian and Economic University	9	9	18	0.45	76.08	A
73	Odesa National Maritime University	3	15	18	0.45	76.53	A

74	Odesa I. I. Mechnikov NU	8	10	18	0.45	76.99	A
75	Ternopil Volodymyr Hnatyuk NPU	9	9	18	0.45	77.44	A
76	NU of Pharmacy	12	5	17	0.43	77.87	A
77	Zaporizhzhia SMU	10	6	16	0.40	78.27	A
78	Bohdan Khmelnytskyi Melitopol SPU	5	11	16	0.40	78.67	A
79	NTU "Dnipro Polytechnic"	7	9	16	0.40	79.08	A
80	Ukrainian State University of Chemical Technology	5	10	15	0.38	79.46	A
81	Dnipropetrovsk Medical Academy of Health Ministry of Ukraine	10	5	15	0.38	79.83	A
82	Kyiv National Linguistic University	9	6	15	0.38	80.21	A
83	NU of "Kyiv-Mohyla Academy"	6	9	15	0.38	80.59	A
84	Yaroslav Mudryi National Law University	4	11	15	0.38	80.97	A

Note: NA – National Academy, NAU – National Agrarian University, NEU – National Economic University, NMU – National Medical University, NPU – National Pedagogical University, NTEU – National Trade and Economic University, NTU – National Technical University, NU – National University, SMU – State Medical University, SPU – State Pedagogical University , STU – state technical university, SU – state university.
Source: author's development.

As you can see, Group A included 84 HEIs of Ukraine (among them no college), the total number of winners of which ranged from 15 to 146. The highest level, and, accordingly, the quality of training (100 or more diplomas) was demonstrated by students of the following four HEIs: Lviv Polytechnic National University; Sumy State University; Taras Shevchenko National University of Kyiv; National Technical University "Kharkiv Polytechnic Institute". The accumulated share of prize winners of this group of HEIs in their total number was 80.97% (Table 1).

Table 2. HEIs of Ukraine according to the results of the ABC analysis (group B)

No	Higher education institution	The number of olympiad prize-winners	The number of prize-winners of the competition	Total number of prize-winners	The share of prize-winners in the total quantity, %	The accumulated share of prize-winners in the total quantity, %	ABC group
85	Oleksandr Dovzhenko Hlukhiv NPU	4	10	14	0.35	81.32	B
86	Prydniprovsk SA of Civil Engineering and Architecture	6	8	14	0.35	81.67	B
87	Odesa NEU	5	9	14	0.35	82.03	B
88	South Ukrainian NPU named after K. D. Ushinsky	9	4	13	0.33	82.35	B
89	Kamianets-Podilskyi Ivan Ohienko NU	6	7	13	0.33	82.68	B
90	National State Tax Service University of Ukraine	10	3	13	0.33	83.01	B
91	Ternopil Ivan Pul'uj NTU	10	3	13	0.33	83.34	B
92	Bila Tserkva NAU	5	7	12	0.30	83.64	B
93	Donetsk NU of Economics and Trade named after Mykhailo Tugan-Baranovsky		12	12	0.30	83.94	B
94	National Transport University	7	5	12	0.30	84.25	B
95	NU of Ostroh Academy	6	6	12	0.30	84.55	B
96	NU of Ukraine on Physical Education and Sport	5	7	12	0.30	84.85	B
97	Podilsky State Agrarian Technical University	6	6	12	0.30	85.15	B
98	Kherson NTU	6	6	12	0.30	85.46	B
99	The Bohdan Khmelnytskyi NU of Cherkasy	4	8	12	0.30	85.76	B

100	Chernihiv NU of Technology	8	4	12	0.30	86.06	B
101	Zhytomyr State Technological University	11		11	0.28	86.34	B
102	Zhytomyr National Agroecological University	5	6	11	0.28	86.61	B
103	Kyiv NU of Construction and Architecture	4	7	11	0.28	86.89	B
104	Mykolaiv NU named after V. O. Sukhomlynskyi	1	10	11	0.28	87.17	B
105	Odesa SA of Civil Engineering and Architecture	5	6	11	0.28	87.45	B
106	Odesa State Environmental University	5	6	11	0.28	87.72	B
107	Ivan Kozhedub Kharkiv National Air Force University	4	7	11	0.28	88.00	B
108	Volodymyr Vinnichenko Central Ukrainian SPU	8	3	11	0.28	88.28	B
109	Donetsk NTU	2	8	10	0.25	88.53	B
110	Uzhgorod NU	8	2	10	0.25	88.78	B
111	Dnipropetrovsk NU of Railway Transport named after academician V. Lazaryan	6	4	10	0.25	89.03	B
112	Ivano-Frankivsk SMU	10		10	0.25	89.29	B
113	University of Customs and Finance	3	7	10	0.25	89.54	B
114	Kharkiv NMU	8	2	10	0.25	89.79	B
115	H. S. Skovoroda Kharkiv NPU	5	5	10	0.25	90.04	B
116	Kryvyi Rih SPU	6	3	9	0.23	90.27	B
117	Kherson SAU	6	3	9	0.23	90.50	B
118	Donbas State Machine-Building Academy	1	8	9	0.23	90.72	B
119	Lviv TEU		9	9	0.23	90.95	B
120	NA of the National Guard of Ukraine		9	9	0.23	91.18	B
121	Odesa NMU	8	1	9	0.23	91.40	B
122	Rivne SU of Humanities	4	5	9	0.23	91.63	B
123	Kherson branch of Admiral Makarov NU of Shipbuilding	1	8	9	0.23	91.86	B
124	Cherkasy State Technological University	3	6	9	0.23	92.08	B
125	Petro Mohyla Black Sea NU	2	7	9	0.23	92.31	B
126	Vinnytsia NMU named after M. I. Pirogov	5	3	8	0.20	92.51	B
127	Zhytomyr Ivan Franko SU	3	5	8	0.20	92.71	B
128	Lviv SU of Physical Culture named after Ivan Bobersky	5	3	8	0.20	92.92	B
129	NA of Statistics, Accounting and Auditing	4	4	8	0.20	93.12	B
130	NU “Chernihiv Collegium” named after T. G. Shevchenko	1	7	8	0.20	93.32	B
131	Lesya Ukrainka Eastern European NU	3	5	8	0.20	93.52	B
132	East Ukrainian Volodymyr Dahl NU	1	7	8	0.20	93.72	B
133	Cherkasy Institute of Fire Safety named after Chernobyl Heroes of NU of Civil Defense of Ukraine	1	7	8	0.20	93.92	B
134	Mariupol SU	3	4	7	0.18	94.10	B
135	Hetman Petro Sahaidachnyi National Ground Forces Academy		7	7	0.18	94.28	B
136	Prydniprovsk SA of Physical Culture and Sport	2	5	7	0.18	94.45	B
137	Uman NU of Horticulture	6	1	7	0.18	94.63	B
138	University of the State Fiscal Service of Ukraine		7	7	0.18	94.81	B
139	Kharkiv SA of Physical Culture	3	4	7	0.18	94.98	B
140	Kharkiv Educational and Scientific Institute of the “University of Banking”		7	7	0.18	95.16	B

Note: NA – National Academy, NAU – National Agrarian University, NEU – National Economic University, NMU – National Medical University, NPU – National Pedagogical University, NTU – National Technical University, NU – National University, SA – State Academy, SAU – State Agrarian University, SMU – State Medical University, SPU – State Pedagogical University, SU – State University, TEU – Trade and Economic University.
Source: author's development.

From the Table 2 shows that group B includes 56 HEIs of Ukraine (also without colleges), in which from 7 to 14 prize winners studied. Their contribution to the total number of prize winners was 14.19%. The difference between the top position of graduates in this group (14) and the bottom in the previous one (15) is 1.

Table 3. HEIs of Ukraine according to the results of the ABC analysis (group C)

No	Higher education institution	The number of olympiad prize-winners	The number of prize-winners of the competition	Total number of prize-winners	The share of prize-winners in the total quantity, %	The accumulated share of prize-winners in the total quantity, %	ABC group
141	Poltava University of Economics and Trade	2	4	6	0.15	95.31	C
142	Luhansk NU named after Taras Shevchenko	1	5	6	0.15	95.46	C
143	Danylo Halytskyi Lviv NMU	6		6	0.15	95.61	C
144	Lviv NU of Veterinary Medicine and Biotechnologies named after S. Z. Gzhytskyj	2	4	6	0.15	95.77	C
145	Kharkiv NU of Internal Affairs		6	6	0.15	95.92	C
146	Alfred Nobel University	2	4	6	0.15	96.07	C
147	Vinnytsia TEI of Kyiv NTEU	1	4	5	0.13	96.19	C
148	Berezhan Agrotechnical Institute	1	4	5	0.13	96.32	C
149	Donbas SPU	2	3	5	0.13	96.45	C
150	SU of Infrastructure and Technology	2	3	5	0.13	96.57	C
151	Dnipropetrovsk SU of Internal Affairs	1	4	5	0.13	96.70	C
152	NA of Internal Affairs		5	5	0.13	96.82	C
153	Odesa SAU	2	3	5	0.13	96.95	C
154	Nizhyn Agrotechnical Institute	3	1	4	0.10	97.05	C
155	Kharkiv Humanitarian and Pedagogical Academy		4	4	0.10	97.15	C
156	Academician Stepan Demianchuk International University of Economics and Humanities	4		4	0.10	97.25	C
157	Odesa SA of Technical Regulation and Quality	2	2	4	0.10	97.35	C
158	Kharkiv SA of Design and Arts	2	2	4	0.10	97.45	C
159	Kharkiv TEI of Kyiv NTEU		4	4	0.10	97.55	C
160	Donetsk SU of Management	1	2	3	0.08	97.63	C
161	Zhytomyr Agro Technical College	3		3	0.08	97.71	C
162	Izmail SU of Humanities	1	2	3	0.08	97.78	C
163	Kyiv NU of Culture and Arts	2	1	3	0.08	97.86	C
164	Lviv Educational and Scientific Institute of University of Banking		3	3	0.08	97.93	C
165	Flight Academy of the National Aviation University	3		3	0.08	98.01	C
166	Mukachevo SU	3		3	0.08	98.08	C
167	NA of the Security Service of Ukraine	2	1	3	0.08	98.16	C

168	Ukrainian National Forestry University	2	1	3	0.08	98.24	C
169	NU “Odesa Maritime Academy”		3	3	0.08	98.31	C
170	Odesa NA of Telecommunications named after O. S. Popov	2	1	3	0.08	98.39	C
171	Kyiv Medical University		3	3	0.08	98.46	C
172	Ukrainian Academy of Printing	1	2	3	0.08	98.54	C
173	Academy of the State Penitentiary Service		2	2	0.05	98.59	C
174	Berdyansk University of Management and Business		2	2	0.05	98.64	C
175	Military Academy		2	2	0.05	98.69	C
176	SU of Telecommunications		2	2	0.05	98.74	C
177	Zhytomyr Military Institute named after S. P. Korolyov	1	1	2	0.05	98.79	C
178	Transcarpathian Academy of Arts		2	2	0.05	98.84	C
179	Luhansk SMU	2		2	0.05	98.89	C
180	Luhansk NAU		2	2	0.05	98.94	C
181	Interregional Academy of Personnel Management	1	1	2	0.05	98.99	C
182	Kherson State Maritime Academy		2	2	0.05	99.04	C
183	Khmelnytskyi University of Management and Law	1	1	2	0.05	99.09	C
184	Cherkasy Medical Academy	2		2	0.05	99.14	C
185	Military Institute of Telecommunications and Informatization named after Heroiv Krut		1	1	0.03	99.17	C
186	Open International University of Human Development “Ukraine”		1	1	0.03	99.19	C
187	Horlivka Institute of Foreign Languages of the Donbas SPU		1	1	0.03	99.22	C
188	Donetsk NMU of the Ministry of Health of Ukraine	1		1	0.03	99.24	C
189	Danube Institute of the NU “Odesa Maritime Academy”		1	1	0.03	99.27	C
190	Institute of Intellectual Property and Law of NU “Odesa Law Academy”	1		1	0.03	99.29	C
191	Institute for Personnel Training of the State Employment Service of Ukraine	1		1	0.03	99.32	C
192	Zhytomyr Medical Institute of the Zhytomyr Regional Council		1	1	0.03	99.34	C
193	Kyiv Cooperative Institute of Business and Law		1	1	0.03	99.37	C
194	Kyiv University of Market Relations		1	1	0.03	99.40	C
195	College of the Sumy NAU		1	1	0.03	99.42	C
196	Kharkiv Humanitarian and Pedagogical Academy	1		1	0.03	99.45	C
197	Konotop Institute of Sumy SU		1	1	0.03	99.47	C
198	Kremenchug Pedagogical College named after A. S. Makarenko		1	1	0.03	99.50	C
199	Kryvyi Rih Institute of Economics, of Kyiv NEU named after Vadym Hetman		1	1	0.03	99.52	C
200	Ladyzhyn College of Vinnytsia NAU		1	1	0.03	99.55	C
201	Lviv SU of Internal Affairs		1	1	0.03	99.57	C
202	Lviv Institute of Economics and Tourism		1	1	0.03	99.60	C
203	Mykolaiv Interregional Institute of Human Development of the Open International University of Human Development “Ukraine”		1	1	0.03	99.62	C
204	International University of Finance	1		1	0.03	99.65	C

205	Educational-Scientific Professional-Pedagogics Institute of the Ukrainian Engineering and Pedagogical Academy		1	1	0.03	99.67	C
206	NA of Public Administration under the President of Ukraine		1	1	0.03	99,70	C
207	NA of the State Border Service of Ukraine		1	1	0.03	99,72	C
208	Ivan Chernyakhovsky National Defense University of Ukraine		1	1	0.03	99,75	C
209	Nizhyn Mykola Gogol SU	1		1	0.03	99,77	C
210	Odesa Institute of the Interregional Academy of Personnel Management		1	1	0.03	99,80	C
211	Poltava Law Institute of Yaroslav Mudryi National Law University	1		1	0.03	99,82	C
212	Ukrainian Catholic University		1	1	0.03	99,85	C
213	Kharkiv NU of Arts named after I. P. Kotlyarevsky	1		1	0.03	99,87	C
214	Khmelnytsky Institute of Social Technologies of the Open International University of Human Development "Ukraine"		1	1	0.03	99,90	C
215	Khmelnytskyi Cooperative TEI		1	1	0.03	99,92	C
216	Cherkasy Educational and Scientific Institute of the University of Banking		1	1	0.03	99,95	C
217	Chernivtsi TEI of Kyiv NTEU		1	1	0.03	99,97	C
218	Shostka Institute of Sumy SU	1		1	0.03	100,00	C
Together		**1638**	**2329**	**3967**	**100.00**		

Note: NA – National Academy, NAU – National Agrarian University, NEU – National Economic University, NMU – National Medical University, NTEU – National Trade and Economic University, NU – National University, SA – State Academy, SAU – State Agrarian University, SMU – State Medical university, SPU – State Pedagogical University, SU – State University, TEI – Trade and Economic Institute.
Source: author's development.

According to the Table 3, group C included the remaining 78 HEIs of Ukraine (including four colleges) with the number of prize winners from 1 to 6. The share of graduates from HEIs of this group in the total number was 4.84%. The difference between the top position of the winners in this group (6) and the bottom in the previous one (7) is also 1.

Generalizing results of ABC analysis are shown in Figure 3.

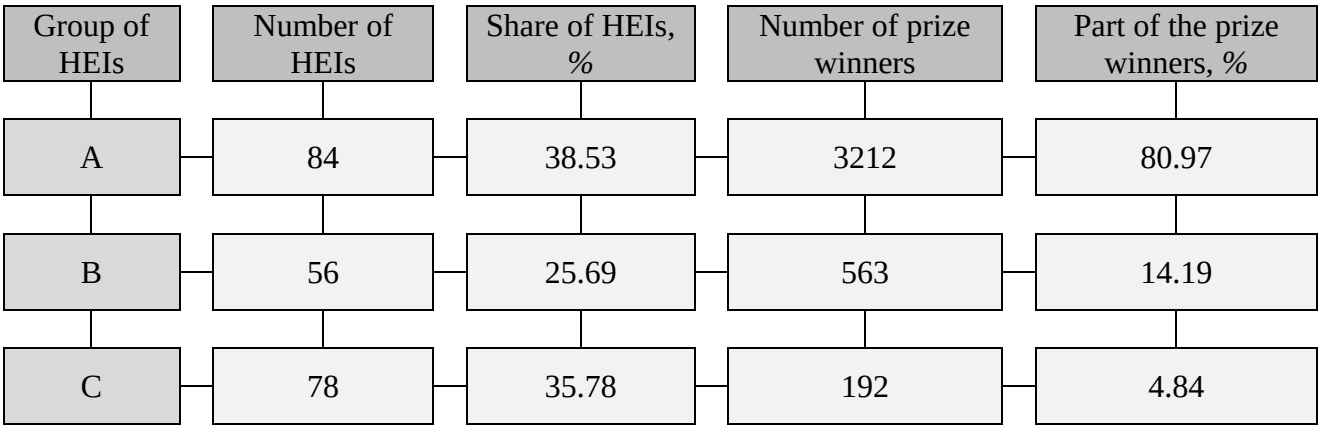

Figure 3. Summarizing results of ABC analysis
Source: author's development.

In our case, the Pareto 20/80 principle was not confirmed, because the training of 80.97% of the prize-winners was provided not by 20, but by 38.53% of HEIs of Ukraine. In this context, the

following recommendations for improving the quality of the provision of educational and scientific services for HEIs will be relevant:

group A – to maintain a high level of quality of the provision of educational and scientific services in terms of preparing students for participation in the olympiad and competition;

group B – to deepen primary scientific work with students;

group C – take effective measures to attract more students and, accordingly, teachers to competitive activities;

for those not included in the analysis of HEIs – to start/strengthen the preparation of students for participation in intellectual competitions.

Discussion. And, finally, we will test the hypothesis about the existence of a "golden intersection" in the indicators of the quality of providing educational and scientific services of HEIs of Ukraine. In our case:

$$\varphi_1=(x+y)/x=((56+78)+84)/(56+78)=(134+84)/134=218/134=1.627, \quad (3)$$

$$\varphi_2=x/y=134/84=1.595. \quad (4)$$

As we can see, both values are extremely close to the reference number $\varphi=1.618$, which confirms the hypothesis we put forward at the beginning of the study. That is, it can be argued that the "golden intersection" can manifest itself not only in architecture, art, biology and medicine, but also in the results of educational and scientific activities (in our case – 134/84 HEIs of Ukraine).

Conclusions. Within the framework of this study, a "golden intersection" was identified in the indicators of the quality of providing educational and scientific services of HEIs of Ukraine based on automated ABC analysis. In particular:

1) a methodology for conducting automated ABC analysis using the Microsoft Excel spreadsheet processor was developed, consisting of 12 steps;

2) on its basis, an ABC analysis of the quality indicators of the provision of educational and scientific services of HEIs of Ukraine for 2018/2019 was carried out in terms of the total number of prize-winners of the All-Ukrainian student olympiad in academic disciplines and specialties (specializations), as well as prize-winners of the All-Ukrainian competition of student scientific works in fields of knowledge and specialties. Recommendations have been formed for HEIs of each group, as well as those that were not included in the rating;

3) the hypothesis about the existence of a "golden intersection" in the quality indicators of the provision of educational and scientific services of HEIs of Ukraine was tested. The ratio of 134/84 HEIs of Ukraine was obtained.

We see the possibility of further research in the following: conducting an automated ABC analysis of other indicators of the activity of HEIs of Ukraine; search for further manifestations of the "golden intersection" in domestic educational analytics; carrying out similar studies on the basis of data from HEIs in other countries of the world.

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«Золотий перетин» у показниках діяльності закладів вищої освіти України

Анотація. Вітчизняна система вищої освіти зобов'язана забезпечувати якість, прозорість і мобільність. Мета статті – виявлення «золотого перетину» в показниках якості надання освітньо-наукових послуг закладами вищої освіти (ЗВО) України на основі автоматизованого ABC-аналізу. Сформовано методику проведення автоматизованого ABC-аналізу за допомогою табличного процесора Microsoft Excel; проведено ABC-аналіз показників якості надання освітньо-наукових послуг ЗВО України в частині сумарної кількості підготовлених призерів Всеукраїнської студентської олімпіади та Всеукраїнського конкурсу студентських наукових робіт; перевірено гіпотезу про наявність «золотого перетину» в показниках якості надання освітньо-наукових послуг ЗВО України.

У групу А увійшло 84 ЗВО України (38,53 % від загальної кількості), які мали від 15 до 146 призерів. Накопичена частка призерів цієї групи ЗВО в їх загальній кількості склала 80,97 %. У групу В увійшло 56 ЗВО України (25,69 % від загальної кількості), які мали від 7 до 14 призерів. Їх внесок у загальну кількість призерів склав 14,19 %. До групи С увійшли 78 ЗВО України (35,78 % від загальної кількості) з кількістю призерів від 1 до 6. Частка дипломантів із ЗВО цієї групи у загальній кількості становила 4,84 %.

Для перевірки гіпотези про наявність «золотого перетину» прийнято, що більшою величиною будуть ЗВО із груп В і С, меншою величиною – ЗВО із групи А. Отримано співвідношення 134/84 ЗВО. Розраховані значення виявилися надзвичайно близькими до еталонного «золотого» числа φ=1,618.

Ключові слова: *заклади вищої освіти України, фінансування, освітньо-наукові послуги, якість надання освітньо-наукових послуг, призери, Всеукраїнська студентська олімпіада, Всеукраїнський конкурс студентських наукових робіт, ABC-аналіз, «золотий перетин», автоматизація.*

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