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APPLICATION OF CLUSTER ANALYSIS TO DETERMINE THE LEVEL OF THE BUDGET POTENTIAL OF THE UKRAINIAN REGIONS

Urgency of the research. Today's realities of financial relations prove the increasing role of regions in ensuring the social and economic development of the country. Therefore, there is a necessity to assess the budget potential and develop directions for its strengthening

Target setting. It is expedient to determine the level of the budget potential of the Ukrainian regions and to develop directions for its strengthening.

Actual scientific researches and issues analysis. An analysis of published scientific work has shown questions of budgetary potential are investigated by such scientists as S. V. Boiko, A. Ye. Buriachenko, N. S. Pedchenko, L. D. Safonova, V. Yu. Strilets, Ye. O. Malik, S. M. Frolov and others. Taking into account the considerable level of scientific research by these authors, it is necessary to continue research on the application of economic and mathematical methods in the study of financial processes, in our case, the use of cluster analysis to determine the level of budget potential of the regions.

Uninvestigated parts of general matters defining. Despite a significant level of theoretical development of budget potential, the following aspects remain unresolved: the methodology for assessing the budget potential of the region, determining the level of budgetary potential, and developing directions for strengthening of budgetary capacity. Therefore, the problem has not lost its relevance today.

The research objective. The object of the article is to study the theoretical issues of the budget potential of the Ukrainian regions and methods for its evaluation, the definition of the Ukrainian regions clusters in terms of budget potential.

The statement of basic materials. The article substantiates the application of cluster analysis for determining the level of budget potential of the Ukrainian regions, clusters of Ukrainian regions are determined by the level of budget potential using cluster analysis and directions for strengthening the budget potential of regions are developed.

Conclusions. One of the priority directions of the Ukrainian regions' budget study should be statistical and mathematical methods, where a special place should be occupied by cluster analysis.

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ЗАСТОСУВАННЯ КЛАСТЕРНОГО АНАЛІЗУ ДЛЯ ВИЗНАЧЕННЯ РІВНЯ БЮДЖЕТНОГО ПОТЕНЦІАЛУ РЕГІОНІВ УКРАЇНИ

Актуальність теми дослідження. Сьогоденні реалії фінансових відносин свідчать про підвищення ролі регіонів у забезпеченні соціально-економічного розвитку країни. Тому виникає необхідність у оцінці бюджетного потенціалу та розробці напрямів його зміцнення.

Постановка проблеми. Доцільним є визначення кластерів регіонів України за рівнем бюджетного потенціалу та розробка напрямів його зміцнення.

Аналіз останніх досліджень і публікацій. Аналіз опублікованих наукових праць показав, що питання бюджетного потенціалу досліджують такі вчені: С. В. Бойко, А. Є. Буряченко, Н. С. Педченко, Л. Д. Сафонова, В. Ю. Стрілець, Є. О. Малік, С. М. Фролов та інші. Беручи до уваги значний рівень наукових досліджень вказаних авторів, слід продовжувати дослідження з питань застосування економіко-математичних методів при вивчені фінансових процесів, застосування кластерного аналізу для визначення кластерів регіонів України за рівнем бюджетного потенціалу.

Виділення недосліджених частин загальної проблеми. Незважаючи на значний рівень теоретичної розробки бюджетного потенціалу, залишаються невирішеними такі аспекти: методика оцінки бюджетного потенціалу регіону, визначення рівня бюджетного потенціалу, розробка напрямів зміцнення бюджетного потенціалу. Тому проблема не втратила своєї актуальності й сьогодні.

Постановка завдання. Метою статті є дослідження теоретичних питань бюджетного потенціалу регіонів України та методів його оцінки, визначення кластерів регіонів Україні за рівнем бюджетного потенціалу.

Виклад основного матеріалу. У статті обґрунтовано застосування кластерного аналізу для визначення рівня бюджетного потенціалу регіонів України, визначено кластери регіонів України за рівнем бюджетного потенціалу з застосуванням кластерного аналізу та розроблені напрями зміцнення бюджетного потенціалу регіонів.

Висновки. Одним з пріоритетних напрямів дослідження бюджетного потенціалу регіонів Україні мають бути статистико-математичні методи, серед яких особливе місце має посідати кластерний аналіз.

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Urgency of the research. The present realities of financial relations indicate an increase in the regions role in ensuring socio-economic development of the country. In Ukraine, there are disproportions between the links of the budget system, which limits the ways of increasing the local budgets funds. Therefore, there appears a need to assess the budgetary potential and develop directions for its strengthening.

Target setting. It is expedient to define the Ukrainian regions clusters by the level of budgetary potential and directions development for its strengthening.

Actual scientific researches and issues analysis. The analysis of published scientific papers showed the questions of budget potential are investigated by such scientists as S. V. Boiko, A. Ye. Buriachenko, N. S. Pedchenko, Ya. Ya. Pushak, L. D. Safonova, V. Yu. Strilets, Ye. O. Malik, S. M. Frolov and others. In the writings by the majority of Ukrainian scholars, this issue was considered from the view of the theoretical aspects, that is, the definition of the term "budget potential of the region", its classification, indicators of its evaluation. Taking into account the considerable level of mentioned authors' scientific research, it is necessary to continue the research on the application of economic and mathematical methods in the study of financial processes, in our case, the application of cluster analysis to determine the Ukrainian regions clusters by the level of budgetary potential.

Uninvestigated parts of general matters defining. Taking into account the considerable level of mentioned authors' scientific research, it is necessary to continue the research on the application of economical and mathematical methods in the study of financial processes, the application of cluster analysis to determine the Ukrainian regions clusters by the budgetary potential level.

The research objective of the article is to study the theoretical issues of the budget potential of Ukrainian regions and methods of its estimation, to define the Ukrainian regions clusters in terms of the budget potential.

The statement of basic materials. There are different approaches to the definition of the essence of the "budget potential of the region" concept in the domestic scientific literature.

From S. M. Frolov's position, the budgetary potential of the border area is characterized by available resources and reflects the ability of local authorities to fulfill their tasks in accordance with the law, that is, the budgetary potential can be interpreted as a balance between the needs of the territory and its capabilities [6].

According to the foregoing, it can be claimed that the region's fiscal capacity is the ability to accumulate financial resources to finance the functions of the state delegated to the local level.

Systematization of scientific achievements in the development of theoretical approaches to budget capacity has allowed us to distinguish the main indicators of the budget potential: the amount of income per inhabitant, the share of tax revenues in the total revenue, the share of non-tax revenues in the total revenue, the share of income from capital operations in the total income, the share of official transfers in the total amount of income, the amount of transfers, which averagely accounts for 1 resident, the share of transfers in the total amount of received income, the share of transfers from the special fund of budget revenues in the total income received and others [2].

Discussions about the definition of the term "budget potential of the region", indicators of its evaluation, continue to this day.

In our opinion, while developing indicators for assessing budgetary potential, we should remember that the regional budget potential is an integral part of the region's financial potential. But, considering the key feature of "budget", it should have specific evaluation indicators that reveal its essence. Therefore, the budget potential should be characterized solely by indicators that can be calculated from the budget, while it is possible to use budget figures per person. That is, other indicators characterizing the financial potential in general, do not allow assessing the budgetary potential of the region with a sufficient degree of objectivity [1; 4].

As for today, there are a number of scientific methodological approaches and methods for assessing the budgetary potential of the region. Let us have a look at some of them.

So, according to S. M. Frolov, four groups of methods are used to assess the budgetary potential: methods based on the use of macroeconomic indicators; methods for calculating the budgetary poten-

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tial, based on official forms of tax reporting based on actually collected tax payments data; method based on regression analysis; method based on the construction of a representative tax system [6].

According to N. S. Pedchenko ta V. Yu. Strilets, the main methods of researching the budget potential of the region include: the methods of theoretical and empirical research, which include the retrospective analysis, the classification method, the system method, the economic-mathematical and statistical methods, including the coefficient method, factor analysis, correlation-regression analysis, forecasting, cluster analysis, qualimetric analysis [5].

One of the methods for studying financial phenomena is cluster analysis. Cluster analysis is a system of mathematical procedures that allows on basis of a indicators plurality that characterize a set of objects, group them into classes in such a way that objects belonging to the same class are more homogeneous, more similar in comparison with the objects included in other classes. And it is better to use cluster analysis using software products, such as STATISTICA.

For conducting cluster analysis, we selected the following indicators: local budget revenues (without transfers) per 1 person, UAH, share of income in financing expenditures (without transfers), tax revenues per person, UAH, local taxes and fees per person, UAH, which, in our opinion, are the most characteristic and reveal the essence of the region budget potential.

Output data for cluster analysis is shown in Tab.1.

Table 1

Indicators for assessing the regions budgetary potential

Region	Revenues of local budgets (without transfers) per 1 person, UAH	Share of revenue in financing expenditures, % (without transfers)	Tax revenues per 1 person, UAH	Local taxes and fees per 1 person, UAH
Vinnitsia	3540,4	41,21	2969,52	863,68
Volyn	2968,2	32,87	2413,1	527,81
Dnipropetrovsk	5534	57,96	4997,69	1519,55
Donetsk	2060	55,57	1797,52	288,32
Zhytomyr	3232,9	36,43	2783,13	652,2
Transcarpathian	2467,8	31,12	2108,14	429,7
Zaporizhzhia	4968,6	55,92	4432,46	1197,92
Ivano-Frankivsk	2651,9	30,25	2292,69	563,48
Kyiv	5321,5	57,64	4500,47	1203,1
Kirovohrad	3676,4	42,09	3281,38	1020,11
Luhansk	1126,7	40,79	991,98	194,28
Lviv	3929	44,11	3418,38	768,52
Mykolaiv	3759,4	45,7	3278,35	926,28
Odesa	4506,5	54,66	3841,64	1270,5
Poltava	4837,4	49,72	4181,74	1188,54
Rivne	2686,5	30,88	2327,47	560,83
Sumy	3606,2	40,23	3129,05	916,84
Ternopil	2420,4	27,88	2033,81	544,68
Kharkiv	4172	51,24	3633,95	1163,52
Kherson	3116	39,75	2603,34	850,33
Khmelnytskyi	3232,8	37,11	2703,18	812,53
Cherkassy	3759,4	41,57	3236,24	1104,46
Chernivtsi	2783,2	34,44	2249,18	535,22
Chernihiv	3513,5	41,85	2981,8	899,88
City of Kyiv	10036,5	87,5	8452,71	2957,71

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Source: created and calculated by the authors on the basis of [3]

In order to determine the level of regions budgetary potential, we made calculations in the STATISTICA package, and the cluster identification for the four indicators.

Tab. 2 shows the results of cluster analysis in the STATISTICA package, where the cluster number is specified.

Table 2

Regions clusters by budgetary potential level

Region	1 Var1	2 Var2	3 Var3	4 Var4	5 CASE_NO	6 CLUSTER	7 DISTANCE
Vinnitsia	3540,4	41,21	2969,52	863,68	1	3	70,61
Volyn	2968,2	32,87	2413,1	527,81	2	4	347,27
Dnipropetrovsk	5534	57,96	4997,69	1519,55	3	2	411,73
Donetsk	2060	55,57	1797,52	288,32	4	4	219,96
Zhytomyr	3232,9	36,43	2783,13	652,2	5	3	269,92
Zakarpattia	2467,8	31,12	2108,14	429,7	6	4	55,96
Zaporizhzhia	4968,6	55,92	4432,46	1197,92	7	2	54,88
Ivano-Frankivsk	2651,9	30,25	2292,69	563,48	8	4	192,42
Kyiv	5321,5	57,64	4500,47	1203,1	9	2	158,29
Kirovohrad	3676,4	42,09	3281,38	1020,11	10	3	117,41
Luhansk	1126,7	40,79	991,98	194,28	11	4	829,02
Lviv	3929	44,11	3418,38	768,52	12	3	243,59
Mykolaiv	3759,4	45,7	3278,35	926,28	13	3	124,63
Odesa	4506,5	54,66	3841,64	1270,5	14	2	380,61
Poltava	4837,4	49,72	4181,74	1188,54	15	2	149,89
Rivne	2686,5	30,88	2327,47	560,83	16	4	215,74
Sumy	3606,2	40,23	3129,05	916,84	17	3	19,80
Ternopil	2420,4	27,88	2033,81	544,68	18	4	46,55
Kharkiv	4172	51,24	3633,95	1163,52	19	3	416,11
Kherson	3116	39,75	2603,34	850,33	20	3	343,30
Khmelnytskyi	3232,8	37,11	2703,18	812,53	21	3	269,87
Cherkassy	3759,4	41,57	3236,24	1104,46	22	3	147,33
Chernivtsi	2783,2	34,44	2249,18	535,22	23	4	226,98
Chernihiv	3513,5	41,85	2981,8	899,88	24	3	68,67
City of Kyiv	10036,5	87,5	8452,71	2957,71	25	1	0,00

Source: created and calculated by the authors

Tab. 3 shows the mathematical characteristics of clusters.

Table 3

Average cluster metrics

Variable	Cluster Means (Spreadsheet58)			
	Cluster No. 1	Cluster No. 2	Cluster No. 3	Cluster No. 4
Var1	10036,50	5033,600	3594,364	2395,587
Var2	87,50	55,180	41,935	35,475
Var3	8452,71	4390,800	3092,574	2026,736
Var4	2957,71	1275,922	907,123	455,540

Source: created and calculated by the authors

On the basis of calculations (Tab. 2 and Tab. 3), we can form 4 clusters, presented in Tab. 4.

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Table 4

The clusters composition and their meanings

	Revenues of local budgets (without transfers) per 1 person, UAH	Share of revenue in financing expenditures, % (without transfers)	Tax revenues per 1 person, UAH	Local taxes and fees per 1 person, UAH
Cluster 1	10036,5	87,5	8452,71	2957,71
City of Kyiv				
Cluster 2	5033,600	55,18	4390.80	1275,922
Dnipropetrovsk				
Zaporizhzhia				
Kyiv				
Odesa				
Poltava				
Cluster 3	3594,364	41,935	3092,574	907,123
Vinnitsa				
Zhytomyr				
Kirovohrad				
Lviv				
Mykolaiv				
Sumy				
Kharkiv				
Kherson				
Khmelnitskyi				
Cherkassy				
Chernihiv				
Cluster 4	2395,587	35,475	2026,736	455,540
Volyn				
Donetsk				
Zakarpattia				
Ivano-Frankivsk				
Luhansk				
Rivne				
Ternopil				
Chernivtsi				

Source: created and calculated by the authors

The highest level of budgetary potential belongs to the cluster 1, its indicators exceed almost twice the indicators of the cluster 2, and almost 4 times the indicators of the cluster 4. In order to answer the question whether the highest level of budgetary potential corresponds to the highest level of socio-economic development of regions, we calculated the average indicators of socio-economic development of regions, presented in Tab. 5 and Tab. 6.

Tables 5

Average indicators of regional economic development per 1 person by clusters in 2016

	Available population income in the calculation per 1 person, UAH	Population expenditures in the calculation per 1 person, UAH	Average monthly salary, UAH	Direct investments per capita by regions of Ukraine, USD
Cluster 1	91356,6	105214	8648	6756,3
Cluster 2	39775,86	54084,8	4962,8	759,14
Cluster 3	32715,53	45410,19	4220,64	219,68
Cluster 4	24770,9	33985,35	4382,5	248,25

Source: created and calculated by the authors on the basis of [3]

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The data in Table 6 indicate that the highest level of budgetary potential of the cluster corresponds to the highest indicators of socio-economic development. The difference between the indicator of the disposable income of the population per 1 person according cluster 1 and the corresponding indicator in the cluster 4 is 66585.7 UAH. The following indices in the clusters 1 and 4 also differ significantly: according to the indicator of population expenditure per 1 person - in the cluster 1 it is three times more than in the cluster 4; according to the average monthly wage - in the cluster 1 it is almost twice as much as in the cluster 4 and according to the indicator of direct investments per 1 person - in the cluster 1 it is twenty-seven times more than in the cluster 4.

Indicators of the regions economic characteristics in terms of clusters confirmed the above statement, but the trend distortion occurred only in the cluster 4, compared with only the cluster 3 for the following indicators: export of goods and imports of goods, direct investments, average monthly wages. This explains that most of these areas have borders with the country cord, so exports and imports of goods are more than in the third cluster.

Table 6

Average indicators of regions economic characteristics by clusters in 2016

	The volume of sold industrial products, UAH million	Agricultural Products, UAH million	Exports of goods, USD million	Import of goods, USD million	Direct investment, USD million
Cluster 1	389401,4	-	8568,8	16137	19296
Cluster 2	159768,58	13949,98	2563,84	1893,54	1723,24
Cluster 3	53072,20	12428,16	716,32	581,36	395,19
Cluster 4	48248,94	6022,60	874,49	595,51	486,91

Source: created and calculated by the authors on the basis of [3]

Conclusions. One of the priority directions of the Ukrainian regions budget potential study should be the use of statistical and mathematical methods, among which a special place should be cluster analysis. We used a cluster analysis in the study of the budgetary potential of the Ukrainian regions, which resulted in identifying 4 clusters of Ukrainian regions at the level of budgetary potential. The city of Kyiv refers to the cluster 1, which has the highest budget capacity indicators, the cluster 2 - the regions of Dnipropetrovsk, Zaporizhzhia, Kyiv, Odesa, Poltava, which have the highest indicators both budgetary potential and socio-economic development among the regions. The cluster 4 covers areas that require the greatest support from the state.

To justify strengthening directions of the budget capacity of the cluster 4 regions, it is necessary to select the priority spheres for the development of these regions and to develop appropriate budget programs taking into account the climatic and socio-economic conditions that will create additional working places in perspective sectors, reduce unemployment, increase the gross regional product, increase tax revenues to the budget.

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