

**FINANCIAL ASPECTS OF SCIENTIFIC ACTIVITY OF HIGHER EDUCATION
INSTITUTIONS IN THE REGIONS OF UKRAINE AND STRATEGY OF
COMMERCIALIZATION OF ITS RESULTS**

**ASPECTOS FINANCEIROS DA ATIVIDADE CIENTÍFICA DE INSTITUIÇÕES DE
ENSINO SUPERIOR NAS REGIÕES DA UCRÂNIA E ESTRATÉGIA DE
COMERCIALIZAÇÃO DE SEUS RESULTADOS**

**ASPECTOS FINANCIEROS DE LA ACTIVIDAD CIENTÍFICA DE LAS
INSTITUCIONES DE EDUCACIÓN SUPERIOR EN LAS REGIONES DE UCRANIA
Y LA ESTRATEGIA DE COMERCIALIZACIÓN DE SUS RESULTADOS**

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ABSTRACT

The purpose of the study is to strategize the commercialization of the results of scientific activities of higher education institutions (hereinafter – HEIs) based on the analysis of the financing of scientific activities in Ukraine and the regions and the development of academic entrepreneurship in HEIs. Methods of analysis and comparison were used to study the dynamics of state budget expenditures on scientific and scientific-technical activities of HEIs of Ukraine; rating assessment – to rank the regions of Ukraine and groups of HEIs; theoretical generalization – to form conclusions and determine the prospects. Expenditures of the state budget for scientific and scientific-technical activity of HEIs and scientific institutions for 2011–2021 are analyzed; the regional and branch focus of commercialization of results of performance by HEIs of scientific and scientific-technical works and rendering of scientific services is considered; the strategy of commercialization of results of scientific activity of HEIs in Ukraine is formed.

Keywords: Financing, Scientific activity, Regions of Ukraine, Higher education institutions, Strategizing

RESUMO

O objetivo do estudo é traçar uma estratégia de comercialização dos resultados das atividades científicas das instituições de ensino superior (doravante - IES) com base na análise do financiamento das atividades científicas na Ucrânia e nas regiões e o desenvolvimento do empreendedorismo acadêmico nas IES. Métodos de análise e comparação foram usados para estudar a dinâmica dos gastos do orçamento do Estado em atividades científicas e técnico-científicas das IES da Ucrânia; avaliação de classificação – para classificar as regiões da Ucrânia e grupos de IES; generalização teórica – para formar conclusões e determinar as perspectivas. São analisadas as despesas do Orçamento do Estado para a atividade científica e técnico-científica das IES e instituições científicas para 2011–2021; considera-se o foco regional e de filiais de comercialização de resultados de atuação por IES de trabalhos científicos e técnico-científicos e prestação de serviços científicos; a estratégia de comercialização de resultados da atividade científica de IES na Ucrânia é formada.

Palavras-chaves: Financiamento, Atividade científica, Regiões da Ucrânia, Instituições de ensino superior, Estratégias

RESUMEN

El objetivo del estudio es esbozar una estrategia para comercializar los resultados de las actividades científicas de las instituciones de educación superior (en adelante, IES) basada en el análisis de la financiación de las actividades científicas en Ucrania y en las regiones y el desarrollo del espíritu empresarial académico en el IES. Se utilizaron métodos de análisis y comparación para estudiar la dinámica de los gastos del presupuesto estatal en actividades científicas y técnico-científicas de las IES en Ucrania; evaluación de clasificación: para clasificar las regiones de Ucrania y los grupos HEI; generalización teórica – para formar conclusiones y determinar perspectivas. Se analizan los gastos del presupuesto estatal para la actividad científica y técnico-científica de las IES e instituciones científicas para el período 2011-2021; se considera el foco regional y las ramas de comercialización de resultados de la

realización por parte de las IES de trabajos científicos y técnico-científicos y prestación de servicios científicos; se forma la estrategia de comercialización de los resultados de la actividad científica de IES en Ucrania.

Palabras clave: Financiamiento, Actividad científica, Regiones de Ucrania, Instituciones de educación superior, Estrategias

1. INTRODUCTION

HEIs of Ukraine, according to the legislation, can introduce elements of entrepreneurship into the practice of their activity. Thus, in the field of scientific and scientific-technical activities, they have the opportunity, in addition to works, researches and expertise, to provide an extremely wide range of services: consulting, information-analytical, organizational, design, production, testing, transfer, licensing, laboratory-diagnostic, providing, etc. (Cabinet of Ministers of Ukraine, 2010). In addition, HEIs of Ukraine of state and communal ownership are allowed to provide a number of paid services in such areas as educational activities, international cooperation, health care, recreation, leisure, health, tourism, physical culture and sports, household, housing and communal services and other services. The customers of these services can be both the state and legal or natural persons, including non-residents.

In the field of scientific activity, the process of commercialization of developments is a set of organizational and economic measures aimed at organizing the movement of intellectual capital for profit (State Committee of Ukraine for Science, Innovation and Informatization, 2010). The basis of innovations at the new stage of innovative transformations of the national economy is scientific developments, the process of commercialization of which in science is called academic entrepreneurship (Zhukov, 2017). Mostly the definition of commercialization of scientific activity is reduced to the economic effect. In our opinion, the commercialization of research results should be defined as a process aimed at the commercial sale of their products in order to obtain socio-economic effects.

Data on the financing of scientific activities of HEIs of Ukraine can be found in the State Budget of Ukraine. The general and special funds are its constituent parts. The general fund accumulates public funds to perform the general functions of state budget institutions. In

turn, funds that are targeted, including the own revenues of budgetary institutions, are credited to a special fund.

In the State Budget of Ukraine, one of the expenditures at the Ministry of Education and Science (hereinafter – MES) of Ukraine is «Scientific and scientific-technical activities of HEIs and scientific institutions» under the program classification of expenditures and lending of the state budget 2201040. The name of this account is periodically modified. Thus, during 2011–2021 it changed six times. Expenditures for this period in terms of general and special funds are shown in Table 1.

Table 1

Expenditures of the state budget at the MES of Ukraine under code 2201040 «Scientific and scientific-technical activities of HEIs and scientific institutions»

Year	Expenditures of the state budget under code 2201040, UAH million	Including the general fund, UAH million	Share of general fund expenditures in the state budget expenditures at the MES under code 2201040, %	Including the special fund, UAH million	Share of special fund expenditures in the state budget expenditures at the MES under code 2201040, %	Indicator of the efficiency of the use of budget funds (expenditures of the special fund / expenditures of the general fund)
2011	204.802	128.046	62.52	76.756	37.48	0.60
2012	471.451	360.639	76.50	110.811	23.50	0.31
2013	444.744	318.188	71.54	126.557	28.46	0.40
2014	458.685	291.539	63.56	167.145	36.44	0.57
2015	564.942	358.848	63.52	206.094	36.48	0.57
2016	671.729	447.328	66.59	224.401	33.41	0.50
2017	864.043	621.477	71.93	242.567	28.07	0.39
2018	929.369	698.080	75.11	231.289	24.89	0.33
2019	968.381	733.255	75.72	235.126	24.28	0.32
2020	1,160.337	832.041	71.71	328.296	28.29	0.39
2021	1,200.079	824.787	68.73	375.292	31.27	0.46

Source: built according to the State Budgets of Ukraine (Verkhovna Rada of Ukraine, 2010–2012, 2014–2020).

Analysis of the dynamics of state budget expenditures on scientific and scientific-technical activities, presented in Table 1, indicates their annual growth, except in 2013. Including the growth of the general fund occurred in all years except 2013–2014, 2021, the special fund – in all years except 2018. That is, funding for scientific and scientific -technical activities both at the expense of public funds (general fund) and own revenues (special fund), mainly increased, which contributed to the development of intellectual capital (Laktionova, Koval, Savina, Gechbaia, 2021). However, in the analyzed period, the share of the general

fund in the total amount of expenditures averaged 69.77 %, special – 30.23 %. In other words, the state invested about 2.3 times more in scientific and scientific-technical activities than HEIs and scientific institutions earned on their own. According to Table 1, the efficiency of the use of budget funds in recent years has been low: for one spent budget hryvnia of the general fund received from 31 to 60 kopecks of the special fund.

The dynamics of shares of expenditures of the general and special fund in the total amount under code 2201040 «Scientific and scientific-technical activities of HEIs and scientific institutions» is shown in Fig. 1.

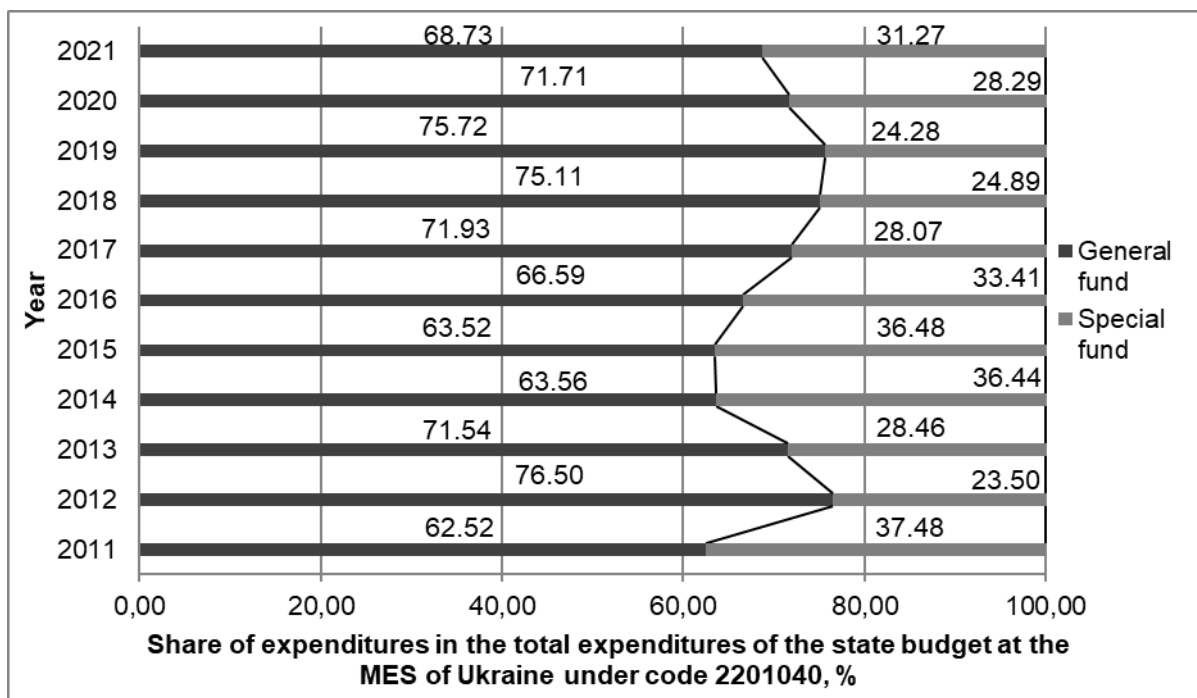


Figure 1. Shares of expenditures of the general and special fund of the state budget at the MES of Ukraine under code 2201040 «Scientific and scientific-technical activities of HEIs and scientific institutions», %

Source: built according to the State Budgets of Ukraine (Verkhovna Rada of Ukraine, 2010–2012, 2014–2020).

The largest share of special fund expenditures in the total state budget expenditures at the MES under code 2201040 «Scientific and scientific-technical activities of HEIs and scientific institutions» was observed in 2011 (37.48 %), the smallest – in 2012 (23.50 %). That is, the level of commercialization of the results of scientific activities of HEIs and scientific institutions in general is not high (Table 2).

Table 2

Expenditures of the special fund of the state budget at the MES of Ukraine under code 2201040 «Scientific and scientific-technical activity of HEIs and scientific institutions»

Year	Special fund, UAH million	Including consumption expenditures		Of them:		Including development costs	
		UAH million	%	wages, UAH million	utilities and energy, UAH million	UAH million	%
2011	76.756		0.00			76.756	100.00
2012	110.811		0.00			110.811	100.00
2013	126.557		0.00			126.557	100.00
2014	167.145	2.845	1.70			164.300	98.30
2015	206.094	3.361	1.63	0.135	0.007	202.733	98.37
2016	224.401	4.112	1.83	0.112	0.038	220.289	98.17
2017	242.567	4.463	1.84	0.134	0.042	238.104	98.16
2018	231.289	7.493	3.24	0.144	0.038	223.796	96.76
2019	235.126	8.093	3.44	0.190	0.042	227.033	96.56
2020	328.296	8.186	2.49	0.104	0.265	320.111	97.51
2021	375.292	8.510	2.27	0.365	0.076	366.782	97.73

Source: built according to the State Budgets of Ukraine (Verkhovna Rada of Ukraine, 2010–2012, 2014–2020).

Thus, in the analyzed period development expenditures (financial support of scientific, investment and innovation activities) accounted for a significant share of expenditures of the special fund of the state budget under code 2201040 «Scientific and scientific-technical activities of HEIs and scientific institutions» – from 96.56 to 100 %. Consumption expenditures (in particular, wages, utilities and energy) in 2011–2013 were absent, and then amounted to less than 4 % of the total expenditures of the special fund of the State Budget of Ukraine.

Note that in 2019 the Cabinet of Ministers of Ukraine approved the formula for the distribution of state budget expenditures on higher education between HEIs based on indicators of their educational, scientific and international activities (Cabinet of Ministers of Ukraine, 2019). The amount of funding provided to the *i*-th HEI of state ownership, depending on the indicators of its activities ($FHEI_i$), is calculated by the formula:

$$FHEI_i = \frac{A_i}{\sum_{i=1}^n A_i} FHEI \quad (1)$$

where $FHEI$ – the amount of funding provided depending on the performance of HEI for the year for HEIs of the state form of ownership, belonging to the sphere of management

of the state customer; A_i – a complex indicator of the activity of the i -th HEI, which is calculated as follows:

$$A_i = EC_i \times S_i \times RS_i \times SA_i \times IR_i \times EG_i \quad (2)$$

where EC_i – the estimated contingent of higher education students studying on the terms of the state order; S_i – indicator of the scale of activity; RS_i – indicator of regional support; SA_i – indicator of scientific activity; IR_i – indicator of international recognition; EG_i – employment rate of graduates (Cabinet of Ministers of Ukraine, 2019).

These indicators should stimulate HEIs to develop in several areas (Fig. 2).

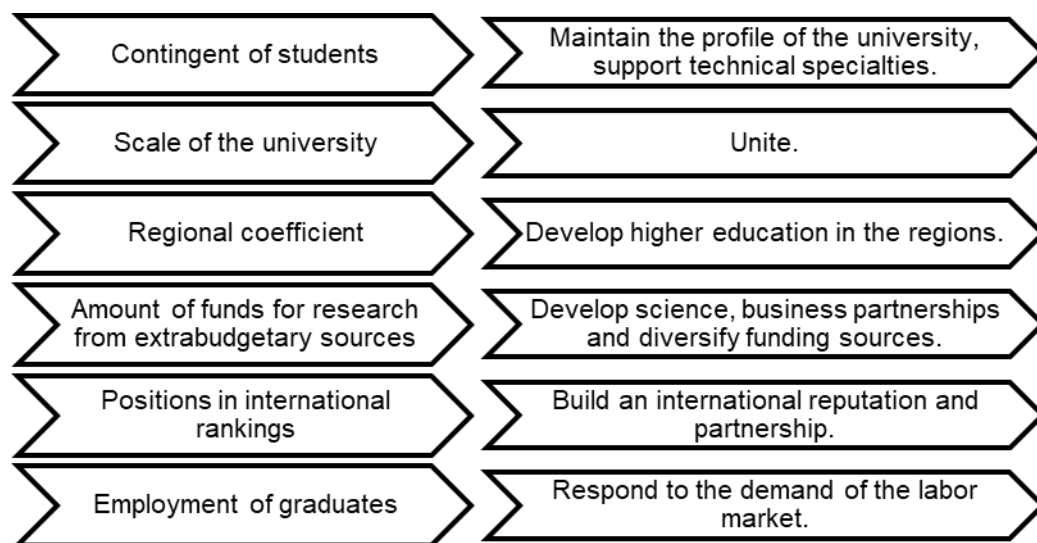


Figure 2. Stimulation of HEIs according to the formula of distribution of expenses of the state budget
Source: built on (Ministry of Education and Science, 2020)

In turn, the indicator of scientific activity of the i -th HEI (SA_i) is determined depending on the amount of funds to the special fund based on the results of scientific and scientific-technical works on international cooperation projects, economic agreements and results of scientific services per scientific and pedagogical worker (SPW) by main place of work (MPW_i) on average for the previous three calendar years and is assumed to be equal to (Cabinet of Ministers of Ukraine, 2019):

- 1 – if MPW_i does not exceed UAH 500 per person;
- 1.1 – if MPW_i is equal to UAH 501–2,000 per person;
- 1.2 – if MPW_i is equal to UAH 2,001–5,000 per person;
- 1.3 – if MPW_i is equal to UAH 5,001–10,000 per person;

1.4 – if MPW_i is equal to UAH 10,001–20,000 per person;

1.5 – if MPW_i exceeds UAH 20,001 per person.

Note that in 2020 the value of $SA_i=1.5$ for four HEIs (Dnieper National University of Railway Transport named after academician V. Lazaryan, Kryvyi Rih National University, National University of «Kyiv-Mohyla Academy», Prydniprovsk State Academy of Civil Engineering and Architecture); $SA_i=1.4$ – for 11 HEIs (Donbas National Academy of Civil Engineering and Architecture, Mykolaiv National Agrarian University, National Aerospace University M. E. Zhukovsky «Kharkiv Aviation Institute», National Technical University of Ukraine «Kyiv Polytechnic Institute named after Igor Sikorsky», National Transport University, National University of Life and Environmental Sciences of Ukraine, Sumy State University, Kharkiv National Automobile and Highway University, O. M. Beketov National University of Urban Economy in Kharkiv, Chernihiv National University of Technology, Ukrainian State University of Chemical Technology) (Ministry of Education and Science, 2020). That is, these HEIs have attracted the largest amount of funds for research from extra-budgetary sources, and, consequently, have a high level of commercialization of research results and entrepreneurial activity.

Since the website of the MES of Ukraine published the data needed to calculate the formula, including absolute and relative (per SPW at the main place of work) indicators of the amount of funds to the special fund based on the results of scientific and scientific-technical works on international cooperation projects, economic agreements and results of scientific services for three years (2016–2018), it made it possible to conduct a comparative analysis of the regional and sectoral aspects of the formation of academic entrepreneurship in Ukraine on the basis of income from research.

2. LITERATURE REVIEW

The results of regional studies of academic entrepreneurship are available in both domestic and foreign scientific literature. In particular, considered the peculiarities of the transformation of academic universities into entrepreneurial ones as drivers of the region's development (Bets, Yaholnyk, 2020); identified the role of business activities of HEIs in alternative, innovation-oriented local and regional growth in the US experience

(Romanovskyi, Romanovska, Romanovska, Makhdi, 2019). In turn, foreign scholars have studied the following aspects: business universities and regional development in the context of the origins of politics, progress and the future with a focus on Poland (Anthony, 2014); the effectiveness of commercialization of universities in Scotland (Brown, 2016); the needs of the ecosystem of micro and small business through the sights of academic entrepreneurship (Culkin, 2016); methodology for assessing and planning the innovative ecosystem of a university located in northeastern Brazil (De Moura Filho, Rocha, Teles, Torres, 2019); the regional ecosystem of business university and the role of university separate companies in the region of Andalusia (Spain) (Fuster, Padilla-Melendez, Lockett, Rosa del-Aguila-Obra, 2019); the economic impact of teaching, research and entrepreneurship in British universities (Guerrero, Cunningham, Urbano, 2015); the impact of business universities in the Boston region (USA) on the development of the local innovation ecosystem (Klein, Lobos Reis de Vasconcelos, Carvalho Lima, Dufloth, 2021); the impact of internal institutional configurations of universities on the production of regional benefits in the UK higher education sector (Sanchez-Barrioluengo, Benneworth, 2019).

It should be noted that some steps to study the commercialization of the results of scientific activities of Ukrainian HEIs were carried out (Author, 2021), where the hypothesis of the Pareto 20/80 principle in terms of revenues to the special funds works and services: for the three-year period (2016–2018) 19.595 % (≈ 20 %) of Ukrainian HEIs provided 79.39 % (≈ 80 %) of income from scientific activities.

3. METHODS

The research methodology consists in applying a number of methods: analysis and comparison – to study the dynamics of state budget expenditures on scientific and scientific-technical activities of domestic HEIs and scientific institutions in terms of general and special funds; rating assessment – for grouping the regions of Ukraine and HEIs according to the level of commercialization of the results of scientific and scientific-technical works and the provision of scientific services; theoretical generalization – to form conclusions and determine the prospects for commercialization of the results of scientific activities of HEIs in Ukraine. The study was based on data from the State Budget of Ukraine (general and special funds) for

2011–2021, information from the MES on the distribution of state budget funding for HEIs in 2020.

4. RESULTS

In 2020, state budget funding was provided by the MES of Ukraine according to the above-mentioned distribution formula (1) among 136 HEIs and 12 of their branches with separate estimates, based on indicators of educational, scientific and international activities for previous 2016–2018. Let's focus on the data for 2018 (Table 3).

Table 3 shows that in terms of the number of state HEIs subordinated to the MES, the leaders (over 10 HEIs) are the following regions: Kyiv (including city Kyiv) – 20 HEIs; Kharkiv (including city Kharkiv) – 18 HEIs; Dnipropetrovsk and Odesa – 15 HEIs, respectively. That is, by geographical location, most HEIs are concentrated in the north, east and south of the country. At the same time, the western regions have the least state HEIs – Volyn, Ivano-Frankivsk and Chernivtsi (two each).

The total amount of revenues to the special fund of the analyzed 148 HEIs based on the results of scientific and scientific-technical works on international cooperation projects, economic agreements and the results of scientific services in 2018 amounted to UAH 352.108 million. The largest contribution (over UAH 10 million) to the overall result was made by the following regions: Kyiv (including city Kyiv) – UAH 90.286 million; Kharkiv (including city Kharkiv) – UAH 58.509 million; Dnipropetrovsk – UAH 54.981 million; Lviv (including city Lviv) – UAH 37.708 million; Sumy – UAH 26.894 million; Odesa – UAH 14.316 million. In turn, less than UAH 1 million was brought by the scientific work of HEIs in Zhytomyr (UAH 0.828 million), Kherson (UAH 0.751 million) and Luhansk (UAH 0.634 million) regions.

Table 3

Rating of regions of Ukraine according to the level of receipts of funds to the special fund of HEIs based on the results of scientific and scientific-technical works

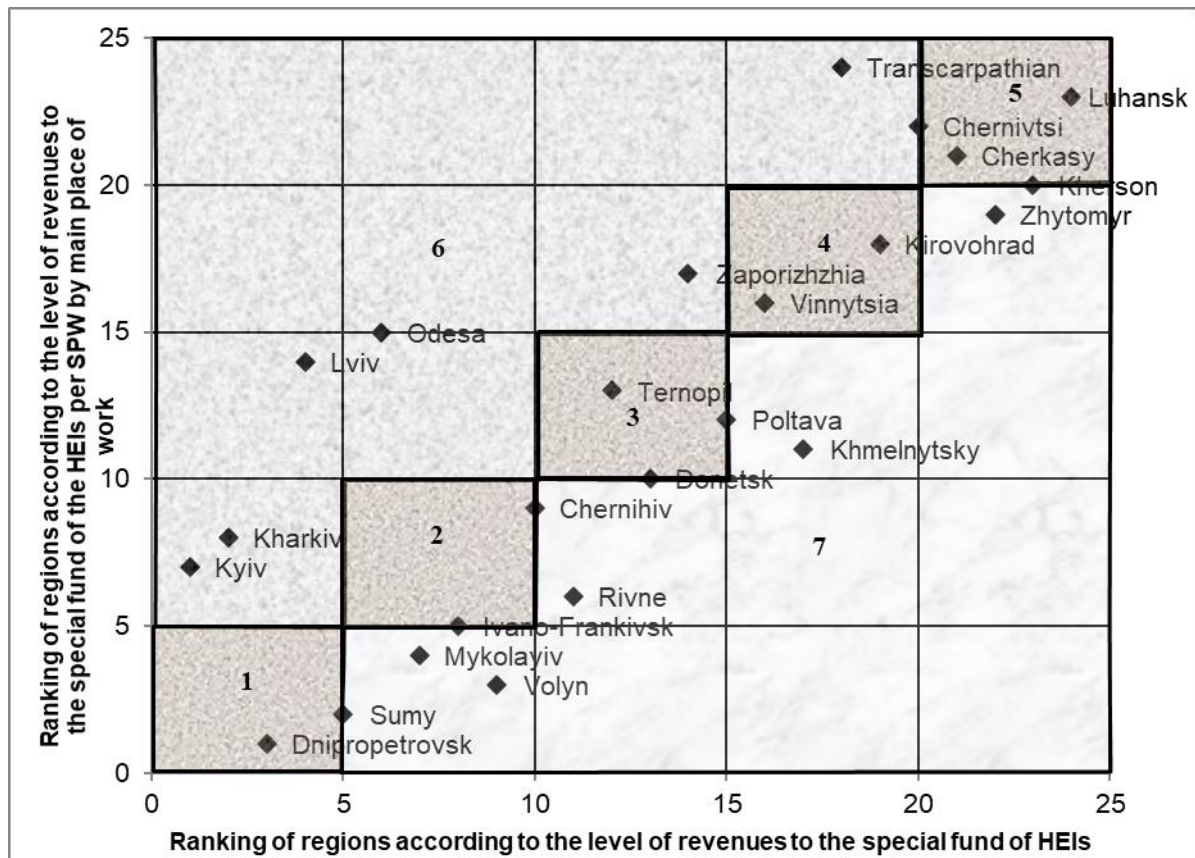
No	HEIs location region	Number of HEIs in the region	Volume of revenues to the special fund, UAH million	The amount of income to the special fund per SPW at the main place of work, thousand UAH	Ranking of regions according to the level of revenues to the special fund of HEIs	Ranking of regions according to the level of revenues to the special fund of HEIs per SPW by main place of work

1	Vinnitsia	5	3.402	1.641	16	16
2	Volyn	2	6.658	6.279	9	3
3	Dnipropetrovsk	15	54.981	8.523	3	1
4	Donetsk	9	5.221	3.748	13	10
5	Zhytomyr	3	0.828	0.893	22	19
6	Transcarpathian	3	1.454	0.380	18	24
7	Zaporizhzhia	5	4.355	1.603	14	17
8	Ivano-Frankivsk	2	9.045	6.201	8	5
9	Kyiv (including city Kyiv)	20	90.286	5.110	1	7
10	Kirovohrad	3	1.267	1.261	19	18
11	Luhansk	3	0.634	0.509	24	23
12	Lviv (including city Lviv)	9	37.708	2.727	4	14
13	Mykolayiv	4	9.098	6.253	7	4
14	Odesa	15	14.316	2.178	6	15
15	Poltava	4	4.232	3.022	15	12
16	Rivne	3	5.436	6.005	11	6
17	Sumy	4	26.894	8.354	5	2
18	Ternopil	4	5.301	2.952	12	13
19	Kharkiv (including city Kharkiv)	18	58.509	4.776	2	8
20	Kherson	4	0.751	0.744	23	20
21	Khmelnytsky	3	3.356	3.741	17	11
22	Cherkasy	4	1.187	0.705	21	21
23	Chernivtsi	2	1.237	0.549	20	22
24	Chernihiv	4	5.951	4.765	10	9
Together		148	352.108			

Source: built on data (Ministry of Education and Science, 2020).

The effectiveness of the commercialization of scientific work of employees of HEIs can be assessed by the relative indicator of the amount of income to the special fund per SPW at the main place of work. Here the leading positions (over UAH 5 ths. per SPW) were occupied by the following regions: Dnipropetrovsk (UAH 8.523 ths.); Sumy (UAH 8.354 ths.); Volyn (UAH 6.279 ths.); Mykolaiv (UAH 6.253 ths.); Ivano-Frankivsk (UAH 6.201 ths.); Rivne (UAH 6.005 ths.); Kyiv (UAH 5.110 ths.). The least productive (<UAH 1.000 ths. per SPW) in this regard were SPWs of HEIs in Zhytomyr (UAH 0.893 ths.), Kherson (UAH 0.744 ths.), Cherkasy (UAH 0.705 ths.), Chernivtsi (UAH 0.549 ths.), Luhansk (UAH 0.509 ths.) and Transcarpathian (UAH 0.380 ths.) regions.

The ratings of the regions of Ukraine on the absolute and relative amount of income from scientific activities to the special fund of HEIs are reflected in the last two columns of the Table 3. On their basis the rating matrix of grouping of regions of Ukraine is constructed (Fig. 3).



Zone 1 – very high level; zone 2 – high level; zone 3 – middle level; zone 4 – low level; zone 5 – very low level; zone 6 – zone of imbalance with the highest level of revenues to the special fund of HEIs; zone 7 – zone of imbalance with the highest level of revenues to the special fund of HEIs per SPW at the main place of work.

Figure 3. Rating matrix of grouping of regions of Ukraine

Source: based on Table 3.

In it, all regions of Ukraine (except the occupied Crimea, not included in the study), are divided into seven zones:

zone 1 – very high level (both rating positions from 1 to 5) – Dnipropetrovsk and Sumy (8.3 % of regions);

zone 2 – high level (both rating positions from 5 to 10) – Ivano-Frankivsk and Chernihiv (8.3 %);

zone 3 – middle level (both rating positions from 10 to 15) – Ternopil, Donetsk and Poltava (12.5 %);

zone 4 – low level (both rating positions from 15 to 20) – Vinnytsia and Kirovohrad (8.3 %);

zone 5 – very low level (both rating positions from 20 to 24) – Chernivtsi, Cherkasy, Kherson and Luhansk (16.7 %);

zone 6 – zone of imbalance with the highest level of revenues to the special fund of HEIs – Kyiv, Kharkiv, Lviv, Odesa, Zaporizhia and Zakarpattia (25 %);

zone 7 – imbalance zone with the highest level of revenues to the special fund of HEIs per SPW at the main place of work – Mykolaiv, Volyn, Rivne, Khmelnytsky and Zhytomyr regions (20.8 %).

For the industry ranking of HEIs of Ukraine according to the level of commercialization of the results of scientific and scientific-technical works and the provision of scientific services, we will unite them into six groups. This is shown in detail in Table 4.

The highest profitability in absolute (over UAH 110 million) and relative (over UAH 7 ths. per SPW) terms was observed in such a group of HEIs as technological, construction and transport. Employees of such group of HEIs as pedagogical, humanitarian, physical education and sports, art and design were the least commercialized in their research.

Ratings of groups of HEIs of Ukraine on absolute and relative volume of receipts of means from scientific activity to special fund of HEIs are reflected in last two columns of Table 4. On their basis the rating matrix of zoning of groups of HEIs of Ukraine in 2018 is constructed (Fig. 4).

In it, the groups of HEIs of Ukraine are divided into two zones:

zone 1 – above average level (both rating positions from 1 to 3) – technological, construction and transport; technical; classic (50 % of groups);

zone 2 – below average level (both rating positions from 4 to 6) – agrarian; legal, economic, management, entrepreneurship and trade; pedagogical, humanitarian, physical education and sports, art and design (50 % of groups).

Table 4

Rating of groups of HEIs of Ukraine according to the level of income from scientific activities to the special fund of HEIs

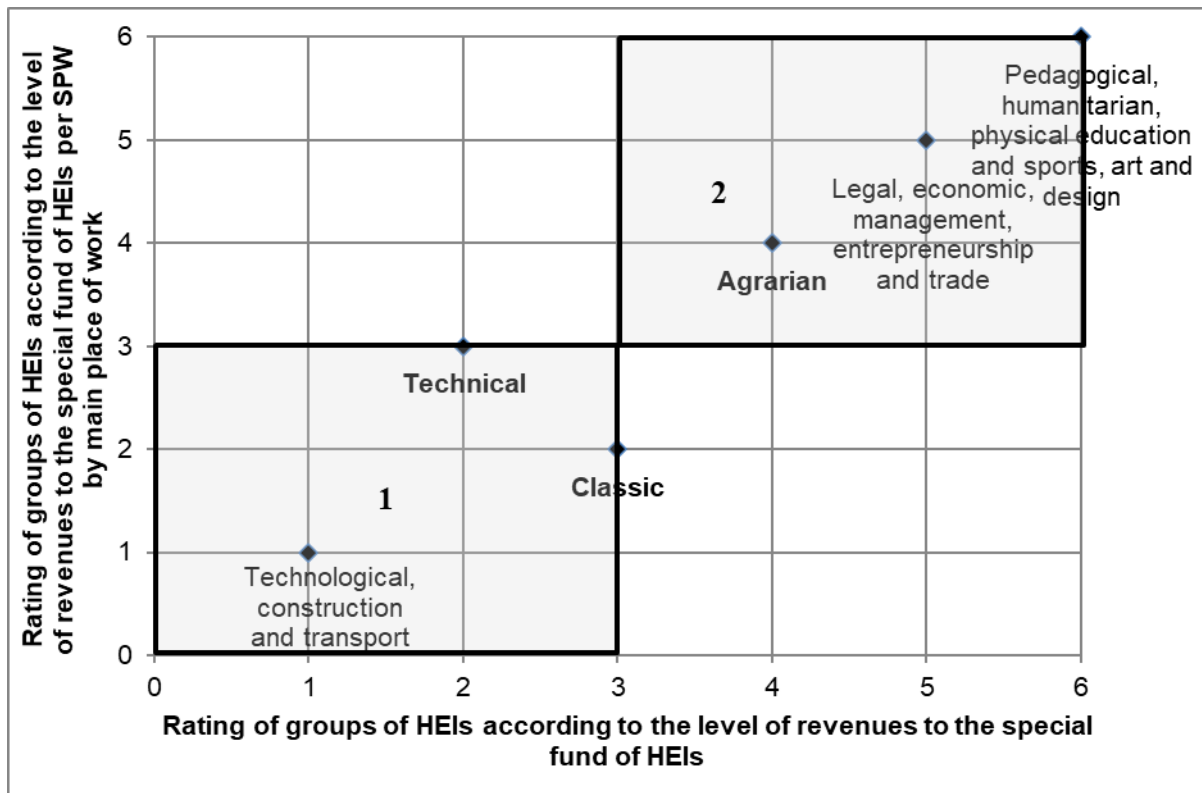
№	Groups of HEIs	Number of HEIs in the group	The amount of income to the special fund, million UAH	The amount of income to the special fund per SPW at the main place of work, thousand UAH	Rating of groups of HEIs according to the level of revenues to the special fund of HEIs	Rating of groups of HEIs according to the level of revenues to the special fund of HEIs per SPW by main place of work
1	Classic	29	93.079	5.131	3	2
2	Technical	22	104.960	4.914	2	3
3	Technological, construction and transport	33	112.546	7.297	1	1
4	Pedagogical, humanitarian, physical education and sports, art and design	26	5.604	0.589	6	6
5	Legal, economic, management, entrepreneurship and trade	19	5.902	0.762	5	5
6	Agrarian	19	30.017	3.541	4	4
Together		148	352.108			

Source: built on data (Ministry of Education and Science, 2020).

Thus, the largest amount of revenues to the special fund based on the results of scientific and scientific-technical works on international cooperation projects, economic agreements and the results of scientific services had HEIs in technology, construction, transport and technical, as well as classical.

Let's evaluate the level of efficiency of commercialization of research results on the example of one of HEIs of Ukraine. To do this, we choose Sumy State University. Our choice

is due to the fact that Sumy region fell into zone 1 in terms of revenues from scientific activities to the special fund of HEIs and the amount of income from scientific activities to the special fund of HEIs per SPW at the main place of work, and Sumy State University is a leader among HEIs in the region according to these indicators. The results of the calculation of the indicator of the efficiency of the use of budget funds (or the level of commercialization) are presented in Table 5.



Zone 1 – above average level; zone 2 – level below average.

Figure 4. Rating matrix of zoning of groups of HEIs of Ukraine

Source: based on Table 4.

Table 5
Financing of scientific- technical activities at Sumy State University

Year	Volume of financing from the general fund, UAH million	Volume of revenues to the special fund, UAH million	Indicator of efficiency of use of budgetary funds (expenditures of the special fund / expenditures of the general fund)
2012	2.677	6.089	2.27
2013	2.610	11.421	4.38
2014	2.090	8.286	3.96
2015	3.307	11.005	3.33
2016	5.325	13.700	2.57

2017	10.432	16.706	1.60
2018	22.806	25.245	1.11
2019	23.027	20.982	0.91
2020	24.289	38.498	1.59

Source: built on data (Sumy State University, 2020).

As you can see, during the analyzed period in all years, except 2019, there was an effective use of budget funds, as per one spent budget hryvnia of the general fund received from UAH 1.11 to UAH 4.38 special fund, which confirms the effective work of the university on the commercialization of scientific and technical activities.

It should be noted that in 2018, 55 state HEIs of Ukraine were millionaires in terms of revenues to the special fund based on the results of scientific and scientific-technical works on international cooperation projects, economic agreements and the results of providing scientific services; another 57 HEIs had lower incomes and 36 institutions did not show entrepreneurial activity in the scientific field (Ministry of Education and Science, 2020). In addition to the low activity of implementing the results of scientific work in production, one of the probable reasons for this situation is that the latter has not established a procedure for commercialization of developments created as a result of scientific and scientific-technical activities (Fig. 5).

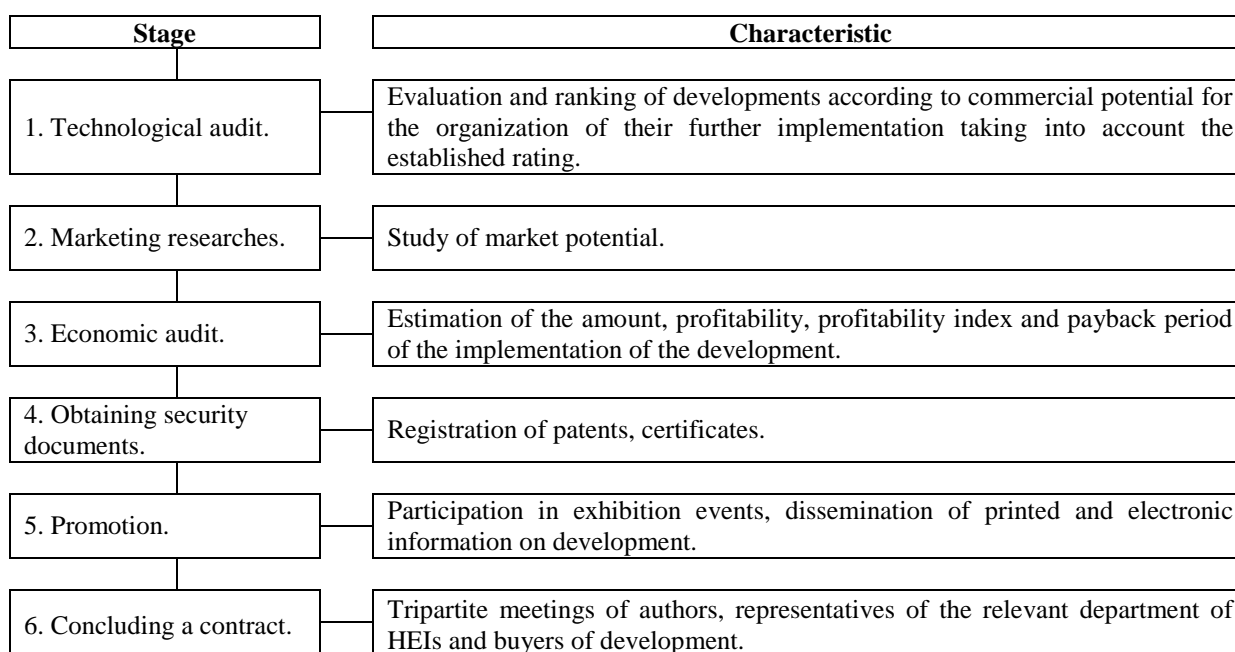


Figure 5. Procedure for commercialization of developments of HEIs and state-owned research institutions

Source: built on the basis of (State Committee of Ukraine for Science, Innovation and Informatization, 2010).

Note that one of the indicators of commercial efficiency of development is the efficiency of investment. The estimate of the sum of the current values of all projected cash flows (NPV), taking into account the barrier rate (discount rate), is calculated in order to determine the effectiveness of the investment in absolute terms (State Committee of Ukraine for Science, Innovation and Informatization, 2010):

$$NPV = PV - I \quad (3)$$

where PV – the current value of incomes, which is the reduction of income for each year to the current date; I – the current cost of costs required to implement the development.

If $NPV > 0$, then the use of development (technology) will bring profit (State Committee of Ukraine for Science, Innovation and Informatization, 2010) and therefore is economically feasible.

In view of this, there is a need to develop a strategy to increase the level of commercialization of the results of scientific activities of HEIs. In particular, it is proposed to establish the following strategic priorities for universities: a complete change in the principles of research; establishing close relations with business; creation of technology companies on the university material and technical base; increasing the number of promising investment projects; increasing the share of international grant and partnership projects; integration into the world, first of all, the European Research Area (Novikova, Zhylinska, Osetskyi, Bediukh, 2020).

In our opinion, the strategy of increasing the level of commercialization of the results of scientific activity (academic entrepreneurship) of HEIs in Ukraine should include a number of stages (Fig. 6).

As you can see, the strategy provides for the management of the commercialization process in the following areas: management of labor (training / retraining of scientific personnel), material (improvement of logistics of scientific and scientific-technical activities) and financial (diversification of funding sources from general and special funds) resources, as well as communications (concluding agreements on scientific and technical cooperation) and quality (creation of scientific and technical products that have passed the technological and economic audit, has the potential for sale). In addition, within the framework of the strategy

implementation, it is expedient to stimulate the scientific activity of SPWs in HEIs. At the level of individual HEI, such incentives may be the awarding of SPWs for the following types of work:

publication of articles in journals indexed in scientometric databases Web of Science / Scopus;

publication of abstracts in proceedings of international conferences indexed in scientometric databases Web of Science / Scopus;

publication of monographs indexed in scientometric databases Web of Science / Scopus;

implementation of agreements within the framework of economic-contractual research work and provision of paid services;

submission of applications and participation in international / joint projects under bilateral agreements / funded by the state budget or the National Research Fund of Ukraine;

received individual grants;

results of annual professional activity.

№	Stage
1	Training / advanced training of scientific personnel.
2	Improving the material and technical support of scientific and scientific-technical activities (including through the Centers for collective use of scientific equipment of the MES of Ukraine).
3	Creation of elements of innovation infrastructure (business incubators, technology parks, science parks, educational and research production complexes, etc.).
4	Concluding agreements on scientific-technical cooperation with HEIs / research institutions, institutions, organizations at the local, regional, sectoral, national and international levels and expanding cooperation with them.
5	Diversification of funding sources at the expense of general (for basic research; applied research; scientific-technical (experimental) developments; preservation of scientific objects of national heritage; conducting international scientific events) and special (for state target programs; by state order; under projects of international cooperation; under economic agreements, etc.) fund.
6	Creation of scientific-technical products (new equipment, new technologies, new materials, plant varieties and animal breeds, methods and theories, etc.), which have passed the technological and economic audit, has the potential for sale.

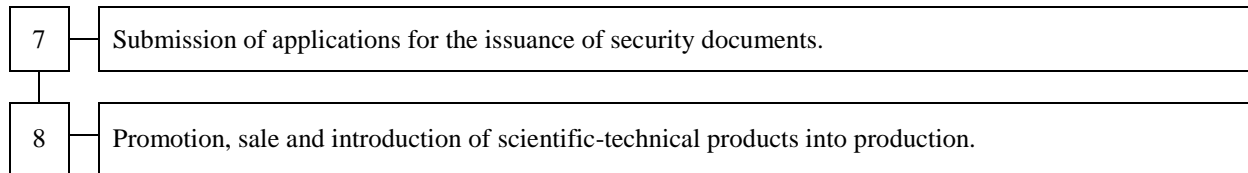


Figure 6. Strategy to increase the level of commercialization of research results of HEIs in Ukraine
Source: author's development.

Researchers should also be encouraged to pursue scientific careers using a range of different methodological tools, such as salary increases, exchange programs, and remuneration (Strikha, 2019). At the same time, the distribution of state budget expenditures between HEIs on the basis of indicators of their scientific, educational and international activities according to the above formula (1) is one of the external incentives.

5. CONCLUSIONS

According to the results of the analysis, during 2011–2021 the efficiency indicators of the state budget funds under code 2201040 «Scientific and scientific-technical activities of HEIs and scientific institutions» were low, as one spent budget hryvnia of the general fund received from 31 to 60 kopecks of special fund.

In the regional context, the most balanced and commercially successful is the scientific activity of SPWs of HEIs in Dnipropetrovsk, Sumy, Ivano-Frankivsk and Chernihiv regions (zones 1–2 of the rating matrix), where not only individual employees work effectively, but also HEIs as a whole. Low level of entrepreneurial activity according to the results of scientific works was observed in Vinnytsia, Kirovohrad, Chernivtsi, Cherkasy, Kherson and Luhansk regions (zones 4 and 5 of the rating matrix). At the same time, such well-known centers with high educational and scientific potential as Kyiv, Kharkiv, Lviv and Odesa regions fell into the zone of imbalance, where the level of revenues from scientific activities to the special fund of HEIs exceeds the level of the amount of revenues from scientific activities to the special fund of HEIs per one SPW at the main place of work. This is the result of the manifestation of the negative effect of the scale of the number of SPWs of HEIs. Employees of a small number of HEIs in Mykolayiv, Volyn, Rivne, Khmelnytsky and Zhytomyr regions work with high efficiency, bring more income from scientific activities per

SPW. In turn, almost half of the regions of Ukraine (45.8 %) are in areas of imbalance, which indicates:

1) sufficiently large amounts of expenditures on science account for a significant number of SPWs, resulting in «blurring» of the total amount of expenditures between individual SPWs;

2) significant amounts of expenditures on science fall on a small number of SPWs, which leads to the accumulation of funds per SPW.

In this context, it is expedient for the development of academic entrepreneurship in HEIs:

a) for HEIs from the regions included in zones 2–5 – gradual transition to zones with a higher level of efficiency of commercialization of scientific results with observance of the procedure of commercialization of developments;

b) for HEIs from the regions covered by zones 6–7 – equalization of imbalance by tightening the unbalanced rating position of the absolute or relative indicator of the amount of income from scientific activities to the special fund of HEIs.

In addition, it is worth emphasizing the importance of cooperation between the HEIs and scientific institutions of the National Academy of Sciences of Ukraine. After all, some of the basic research and innovative developments of the latter have no analogues not only in Ukraine but also in the world, which indicates their significant commercial potential.

The urgent need for commercialization of scientific activities of HEIs of Ukraine is due to the fact that, first, the science intensity of domestic GDP is steadily declining and has already crossed the critical limit (less than 0.9 % of GDP), where science does not perform economic function; secondly, in contrast to most developed countries, the state share in funding for research and development in Ukraine is more than 30 %.

The main measures for the development of commercialization of scientific activities of HEIs are the introduction of: organizational and marketing activities (bonuses for employees within HEIs based on the results of certain types of scientific works and their annual activities (including scientific, project and grant); state budget expenditures on higher education between HEIs based on indicators of their activity (including scientific) according to the distribution formula (1); integration of scientific, educational and industrial activities in the

higher education system; expansion of partnerships with external stakeholders; marketing research); economic measures (diversification of funding sources, including the attraction of resources within the programs of grant support for research (Strikha, 2016; Horyn, Koval, 2021); economic audit of developments; preferential taxation); institutional measures (development of institutions of regional innovation infrastructure of scientific- technical activities; public-private partnership in the field of science and innovation; state order for scientific-technical developments).

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