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ORGANIZATIONAL AND FINANCIAL DETERMINANTS OF THE INNOVATIVE COMPONENT OF THE COUNTRY'S COMPETITIVENESS

Abstract. The article identifies the impact of sources of funding for innovation in the country on economic growth through economic and mathematical modeling and construction of regression equations between GDP and funding for innovation and research costs with the construction of a multifactor regression equation. As a result of regression analysis, it was found that the most significant impact on the resulting indicator have such variables as capital investment from state and local budgets and research and development costs. Using the method of extrapolation, GDP growth was forecast for 4 years, and it was found that capital investment from own funds of enterprises and organizations will grow by 24,08%, capital investment from state and local budgets by 28,42%, research costs and development by 22,76% for the analyzed period. Subject to compliance with the projected values of the financial determinants of the innovative component of increasing the country's competitiveness, the volume of estimated GDP in actual prices for the forecast period will increase by 936039,011 million UAH or 23,26%.

The reasons for the low level of the state of the innovation sphere in the domestic economy are outlined: underdevelopment of the market of innovative products due to low indicators of development of integration processes in it; weakness of relations that determine the innovative nature of economic development; low motivation of the industrial sector in innovative development; the supply of technological innovations created by national industrial companies and research institutions in the domestic market is limited; high cost of development and implementation, high interest rates on the investment portfolio, a long payback period, the focus of financial institutions on the issuance of «short loans», usually consumer loans for technological renewal of industrial sectors. To resolve such contradictions, the system-forming factors of a set of measures to intensify integration processes in the innovation sphere of Ukraine were proposed.

Systematized foreign experience in scientific, technical and innovation policy, as well as commercialization of innovations, taking into account which proposed conceptual guidelines for

organizational and financial support of the effectiveness of the innovative component of competitiveness: economic mechanisms (direct budget investments; preferential lending; integration with foreign institutions; financial activities; increase the share of GDP aimed at financing innovation processes, development of an effective set of measures to attract international grants and household savings as investments to implement the concept of innovative development of the country's economy, etc.); organizational mechanisms (formation of integration clusters using the potential of education, business, government, public; state assistance in the development of innovation infrastructure, etc.).

Keywords: innovations, financial support of innovative development, country competitiveness, innovation system, cluster, regression, correlation, integration processes.

JEL Classification O11, O19, O16, O33, E62, F20

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ОРГАНІЗАЦІЙНО-ФІНАНСОВІ ДЕТЕРМІНАНТИ ІННОВАЦІЙНОЇ СКЛАДОВОЇ КОНКУРЕНТОСПРОМОЖНОСТІ КРАЇНИ

Анотація. Визначено вплив джерел фінансування інноваційної діяльності в країні на економічне зростання країни за допомогою економіко-математичного моделювання і побудови рівнянь регресії між ВВП і показниками фінансування інновацій та витрат на дослідження з побудовою багатofакторного рівняння регресії. У результаті регресійного аналізу було виявлено, що найбільш чуттєвий вплив на результуючий показник мають такі змінні, як капітальні інвестиції з коштів державного і місцевих бюджетів та витрати на дослідження і розробки. За допомогою методу екстраполяції було прогнозовано зростання ВВП на чотири роки, а також виявлено те, що капітальні інвестиції з власних коштів підприємств і організацій зростуть на 24,08 %, капітальні інвестиції з коштів державного і місцевих бюджетів на 28,42 %, витрати на дослідження і розробки на 22,76 % за аналізований період. За умови дотримання прогнозованих значень фінансових детермінант інноваційної складової нарощення конкурентоспроможності країни обсяг розрахункового ВВП у фактичних цінах за прогнозований період зросте на 936 039,011 млн грн, або 23,26 %.

Окреслено причини низького рівня стану інноваційної сфери у вітчизняній економіці: нерозвиненість ринку інноваційних продуктів через низькі показники розвитку інтеграційних процесів у ній; слабкість відносин, що визначають інноваційний характер економічного розвитку; низька мотивація промислового сектору в інноваційному розвитку; на вітчизняному ринку обмежена пропозиція технологічних інновацій, створених силами національних промислових компаній і науково-дослідних установ; висока вартість розроблення і впровадження, високі процентні ставки за інвестиційним портфелем, тривалий період окупності, орієнтація фінансових структур на видачу «коротких позик», здебільшого споживчих кредитів, на технологічне оновлення секторів промисловості. Для врегулювання подібних протиріч було запропоновано системоутворювальні фактори комплексу заходів активізації інтеграційних процесів у інноваційній сфері України.

Систематизовано зарубіжний досвід ведення науково-технічної та інноваційної політики, а також комерціалізації інновацій, зважаючи на який, запропоновано концептуальні орієнтири організаційно-фінансового забезпечення ефективності інноваційної складової конкурентоспроможності: економічні механізми (прямі бюджетні інвестиції; пільгове кредитування; інтеграція з іноземними інституціями щодо фінансового забезпечення інноваційної діяльності; збільшення частки ВВП, спрямованої на фінансування інноваційних процесів; розроблення дієвого комплексу заходів щодо залучення міжнародних грантів і заощаджень домогосподарств як інвестицій для реалізації концепції інноваційного розвитку економіки країни тощо); організаційні механізми (формування інтеграційних кластерів з використанням потенціалу освіти, бізнесу, влади, громадськості; державне сприяння розбудові інноваційної інфраструктури тощо).

Ключові слова: інновації, фінансове забезпечення інноваційного розвитку, конкурентоспроможність країни, інноваційна система, кластер, регресія, кореляція, інтеграційні процеси.

Формул: 1; рис.: 5; табл.: 3; бібл.: 12.

Introduction. In the conditions of aggravation of the world competition, constant modernization of technologies, increase of a role of partnership and strategic alliances, the most important factor capable to provide efficiency of the industrial enterprise becomes innovative activity. The global innovation system is currently characterized by increased dynamism: the growing intensity of innovation processes, reducing the time to create innovations, developers and consumers are new actors in innovation, changing their relationships and, consequently, functions. Transformations in the world innovation system and its dynamism dictate the need to build an up-to-date model of innovation. The current model of economic development of Ukraine is characterized by the dominance of vertical relations within the outdated «double spirals», which complicates the transition to a new trajectory of the innovation system. Achieving the sustainability of innovative development requires the transformation of the institutional matrix aimed at organizational and financial support of innovation activity of economic entities in the development of their own technological innovations. The above determines the relevance of the chosen topic and objectives of the study.

Analysis of research and problem statement. Theoretical and practical aspects of the problems of financing innovation and development are devoted to a large number of scientific works of domestic and foreign scientists, namely: M. Abramovytsia, L. Antonyuk, Y. Bazhala, V. Heitz, E. Denison, P. Drucker, V. Zanko, A. Kazantseva, I. Manaenko, G. Mensha, R. Mueller, R. Nelson, A. Lieutenant, J. Sey, N. Syrotynska, B. Twiss, S. Tyvonchuk, M. Tugan-Baranovsky, J. Schumpeter, R. Foster and others. Despite the considerable amount of scientific work on the development of the innovation paradigm, the issues of financial support of the innovative component of the country's competitiveness need further research to improve in the context of ensuring the country's competitiveness.

The purpose of this article is: determining the impact of sources of funding for innovation in the country (capital investment from own funds of enterprises and organizations, capital investment

from state and local budgets and research and development costs) on economic growth through economic and mathematical modeling and construction of regression equations between GDP and indicators of funding for innovation and research costs; outline the reasons for the low level of innovation in the domestic economy; to propose system-forming factors of a set of measures to intensify integration processes in the innovation sphere of Ukraine; to systematize foreign experience in conducting scientific, technical and innovation policy, as well as the commercialization of innovations; to offer conceptual guidelines for organizational and financial support of the efficiency of the innovative component of the country’s competitiveness.

Research results. The impact of sources of funding for innovation in the country and the cost of funding its own research and development or external research on economic growth can be determined by economic and mathematical justification and construction of regression equations between GDP and innovation funding indicators and cost research.

Among the financial determinants of the innovative component of increasing the country’s competitiveness, it is advisable to single out the indicators of capital investment from own funds of enterprises / organizations, capital investment from state and local budgets, research and development costs, as well as costs for financing external research and acquisition of foreign knowledge in 2010—2019 [8].

One of the main criteria for determining the level of innovation of the national economy is the volume of capital investment from own funds of enterprises and organizations, as well as capital investment flows from state and local budgets (Fig. 1).

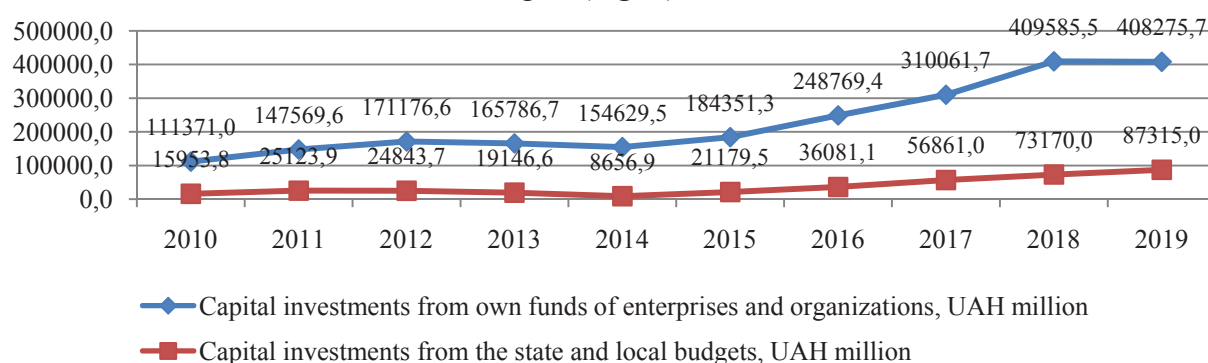


Fig. 1. Volumes of capital investments from own funds of enterprises / organizations and from state and local budgets for 2010—2019

Source: built according to [1].

According to the State Statistics Service of Ukraine (see Fig. 1) for the period 2010—2019 there is a gradual increase in capital investment from own funds of enterprises / organizations and from state and local budgets.

Expenditures on research and development, as well as expenditures on financing external research and acquisition of external knowledge for 2010—2019 are shown in Fig. 2.

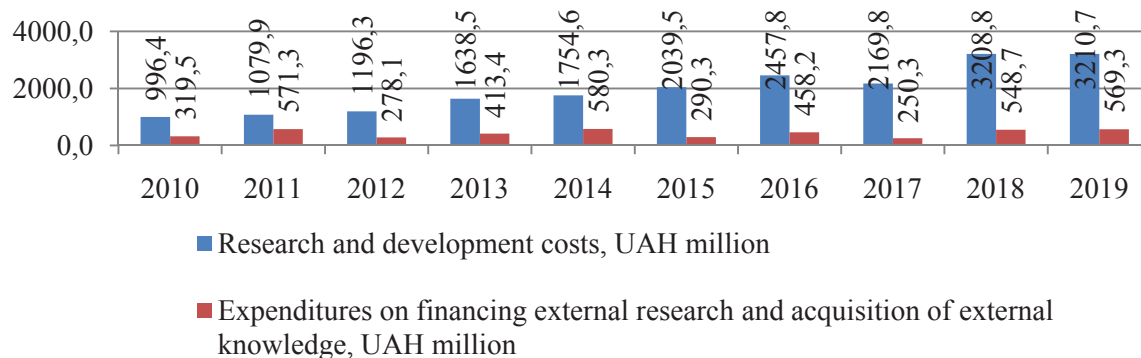


Fig. 2. Expenditures on research and development, as well as expenditures on financing external research and acquisition of external knowledge for 2010—2019

Source: built according to [1].

The use of economic and mathematical tools «Data Analysis» in general and the function «Regression» in particular on the indicator «Volumes of capital investments from own funds of enterprises / organizations» are reflected in Fig. 3.

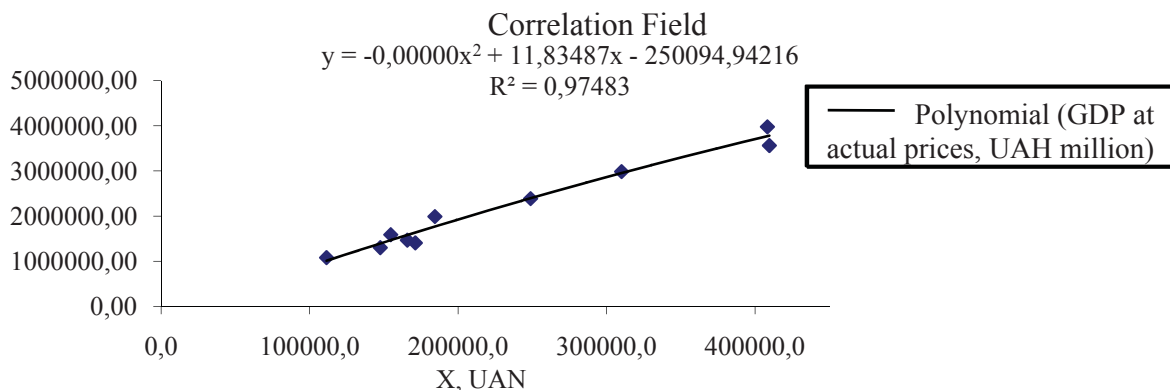


Fig. 3. Graphical representation of economic and mathematical modeling of the impact of capital investment from own funds of enterprises / organizations on GDP

Sums of statistical and estimated values of GDP in actual prices, UAH million differ only by 14% (21729072,0 and 24856263,93 million UAH) and their dynamics coincide, which confirms the reliability and correctness of the selected equation, which describes the dependence. We analyze the compliance of the constructed model, in particular, check its adequacy to statistical data, using Fisher’s criterion. To do this, calculate the calculated value of the criterion by the formula:

$$F_{calc.} = \frac{R^2}{1 - R^2} * \frac{n - m - 1}{m},$$

accordingly $F_{calculated} = 309,838697$.

Since the inequality $F_{calculated} > F_{table}$ ($309,838697 > 5,32$), then with probability $p = 0,95$ we state that the constructed model is adequate to statistical data and is suitable for further analysis and forecasting.

Value of the correlation coefficient $r [x; y] = 0,986608$.

From the obtained value we make the following conclusion: since $r [x; y] > 0$, the relationship between X and Y is direct, with an increase in capital investment from own funds of enterprises / organizations, GDP in actual prices will increase, because $0,7 < | r [x; y] | < 1$, the relationship between X and Y is strong. Evaluate the effect of variation of factor X on the variation of Y , using the coefficient of determination, which is: $R^2 = 0,97483$, that is the variation of 97,48% due to variation of the factor. $Kel.av. = 1,125095915$. Thus, with increasing dynamics of capital investment from own funds of enterprises / organizational 1%, GDP in actual prices will increase by 1,13 %.

Analyzing Fig.4 it should be noted that $Kel. av.$ is 0,549509506, with an increase in the level of capital investment from state and local budgets (Cib) in Ukraine 1%, GDP in actual prices will increase by 0,55%. Fisher’s calculation criterion is 22,252609, which is more than the tabular value and confirms the adequacy of the model, the coefficient of determination $R^2 = 0,91154$, that is the variation of B (GDP at actual prices, UAH million) by 91,15% due to the variation of the factor Cib. The correlation coefficient $r [x; y] = 0,953974431$, that is the relationship between X and Y is straight and strong.

Under the current dynamics of globalization of the economy and the environment, the level of priority of intellectual capital is increasing, the effectiveness of which is directly related to the volume of research and development (Vrd).

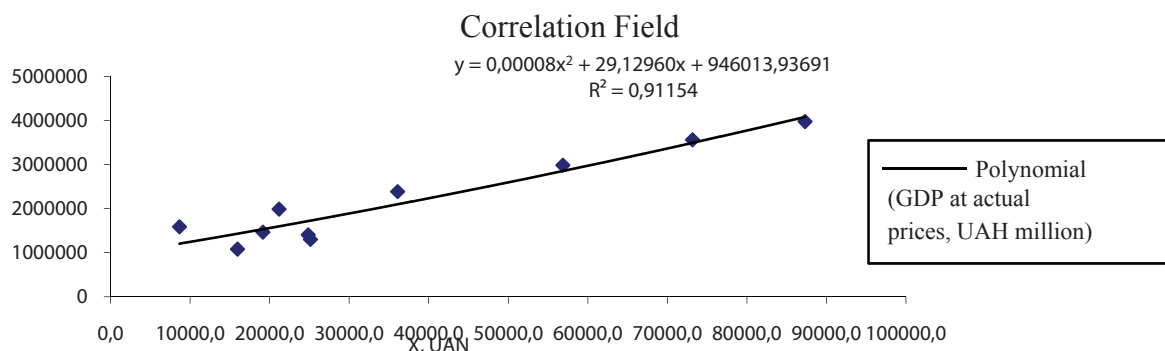


Fig. 4. Graphic representation of economic and mathematical modeling of the impact of the level of capital investment from the state and local budgets (Cib) of GDP

Table 1 shows the results of economic and mathematical modeling of the interdependence between GDP and the dynamics of spending on research and development, Table 2— between GDP and the dynamics of expenditures on financing external research and acquisition of external knowledge in Ukraine for 2010—2019.

As can be seen from Table 1, are characterized by a high level of coefficient of determination, which confirms the presence of the relationship and the correctness of the model. In addition, the correlation coefficient is 0,94943, that is the relationship between the factors is strong and direct.

Table 1

The results of economic and mathematical modeling of the relationship between GDP and the dynamics of spending on research and development (Vrd) in Ukraine in 2010—2019

The equation that describes the relationship of GDP million UAH from the dynamics of research and development costs in Ukraine in 2010—2019	Coefficient of determination
$y = 1196,98771x - 191418,82880$	$R^2 = 0,90142$
$y = 2202564,58405 \ln(x) - 14369467,90407$	$R^2 = 0,83540$
$y = 0,21177x^2 + 298,67818x + 632822,38182$	$R^2 = 0,91455$
$y = 966,43039x^{1,01513}$	$R^2 = 0,89917$
$y = 684727,37361e^{0,00054x}$	$R^2 = 0,91974$

As can be seen from Table 2, are characterized by a low level of coefficient of determination, which confirms the lack of connection and inadequacy of the model. Confirmation of this statement is also the low value of the calculated value of the Fisher coefficient: 1,169685 < 5,32 (F table = 5,32).

Table 2

The results of economic and mathematical modeling of the relationship between GDP and the dynamics of expenditures for financing external research and acquisition of external knowledge in Ukraine for 2010—2019

The equation that describes the relationship of GDP million UAH from the dynamics of costs for financing external research and acquisition of external knowledge in Ukraine for 2010—2019	Coefficient of determination
$y = 2068,39017x + 1287760,30878$	$R^2 = 0,07552$
$y = 746464,96097 \ln(x) - 2313605,01296$	$R^2 = 0,06058$
$y = 23,76399x^2 - 18016,12394x + 5140630,07983$	$R^2 = 0,12756$
$y = 369772,07694x^{0,27903}$	$R^2 = 0,04289$
$y = 1412840,38876e^{0,00079x}$	$R^2 = 0,05534$

Deepening the analysis in this area, it is advisable to build the equation of GDP dependence on a group of indicators that are financial determinants of the innovative component of increasing the country's competitiveness, the strong impact of which on Ukraine's GDP was determined by two-factor economic and mathematical modeling: volumes of capital investments from own funds of enterprises / organizations (Ciofe)(X1), level of capital investments from state and local budgets (Cib) (X2), volumes of expenses for research and development (Vrd) (X3). The results of using the software product Excel — DataAnalysis — Regression are shown in Fig. 5. The equation of the interdependence of GDP on selected indicators is characterized by the following content:

$$Y = 102460,3717 + 2,443737422X_1 + 13,98692402X_2 + 501,3976276X_3$$

SUMMARY OUTPUT

Regression Statistics					
Multiple R		0,992236864			
R Square		0,984533994			
Adjusted R Square		0,976800992			
Standard Error		154836,1311			
Observations		10			
ANOVA					
	df	SS	MS	F	Significance F
Regression	3	9,1569E+12	3,0523E+12	127,3158721	8,04542E-06
Residual	6	1,43845E+11	23974227484		
Total	9	9,30074E+12			
	Coefficients	Standard Error	t Stat	P-value	Lower 95%
Intercept	102460,3717	187572,4592	0,54624422	0,60459946	-356512,9017
X Variable 1	2,443737422	3,907167561	0,625449865	0,554703722	-7,116757188
X Variable 2	13,98692402	10,7809361	1,297375654	0,242149303	-12,39307629
X Variable 3	501,3976276	241,9453082	2,072359374	0,083614024	-90,62121442

Fig. 5. The results of regression analysis of the multifactor model

The most significant impact on the resulting indicator have such independent variables as capital investment from state and local budgets and research and development costs. It is quite logical to conclude that the growth of such indicators will characterize the innovation of the economy and its competitiveness. Method of extrapolation according to the current trend predicts a moderate increase in independent factors, including capital investment from own funds of enterprises and organizations will increase by 24,08%, capital investment from state and local budgets by 28,42%, research costs and developed 22,76% for the analyzed period.

Predicting independent indicators using the method of extrapolation, we can determine GDP growth over the next 4 years (Table 3).

Table 3

GDP forecasting based on a multifactor model

Predictive dependent and independent variable equations	2020	2021	2022	2023	Absolute changes	Relative changes, %
Capital investments from own funds of enterprises and organizations, UAH million	413802,7	447010,8	480219,0	513427,2	99624,5273	24,08
Capital investments from state and local budgets, UAH million	76899,4	84184,1	91468,9	98753,6	21854,2927	28,42
Research and development costs, UAH million	3389,9	3647,2	3904,4	4161,6	771,66	22,76
Estimated GDP in actual prices, UAH million	4023664,6	4335677,6	4647690,6	4959703,6	936039,0	23,26

Subject to compliance with the projected values of the financial determinants of the innovative component of increasing the country's competitiveness, the volume of estimated GDP in actual prices for the forecast period will increase by 936039,0 million UAH, or 23,26%.

Thus, to achieve the maximum positive synergetic effect in the innovation sphere, the activities of entities should be based on the growth of investment in innovation in proportion to the volume of innovative products, which should be directed primarily to the first stage of the innovation process — research and development.

One of the reasons for the low level of the state of the innovation sphere in the domestic economy is the underdevelopment of the market of innovative products due to low rates of development of integration processes in it. The formation of market relations in this sector is complicated by difficulties associated, on the one hand, with the specifics of scientific and technical products as a commodity and, on the other hand, the weakness of relations that determine the innovative nature of economic development.

Analysis of foreign experience in conducting scientific, technical and innovation policy [9; 10], as well as the commercialization of innovations, revealed the following: high-tech industrial complex is seen as a generator of scientific, technical and innovative development, as a growth point of the national economy; the level of innovation activity in the country directly depends on the participation and support of the state; creation and development of innovation infrastructure in the form of a network of technology parks, clusters, business incubators, etc.; increasing the level of motivation of participants in innovation and the role of intellectual capital in the innovation sphere; shifting the emphasis to the project approach to innovation management, taking into account the economic efficiency of innovative developments; institutional support of innovation activity; accelerating innovation processes and expanding the boundaries of their implementation through the active use of information and communication technologies; active use in innovation activities and management of innovation processes of methods of benchmarking, technical and economic analysis and controlling [2; 3, p. 30—31; 4, p. 17—21; 5].

The model of innovative development of Ukraine can be better described as a «supply model», which provides for such phases as: research, pilot production, industrial production and marketing. However, as the analysis of successful innovation economies has shown, the innovation process does not begin with research, but with a preliminary assessment of the potential of innovation. This is a model of «demand attraction», which includes a number of stages: studying the prospects for growth and development for business, preliminary analysis of the market and the possibility of finding a market niche, or forming a new market, investment evaluation, preliminary feasibility study, marketing research, testing product within the organization, product development, preparation of technical and economic and design documentation (only at this step research work begins), product testing in the market, experimental production, preliminary business analysis of the product and production before the main production, production start, market introduction.

Another important problem of the domestic economy is the weak motivation of the industrial sector in innovative development. The supply of technological innovations created by national industrial companies and research institutions is limited in the domestic market. The reasons for this situation are: high cost of development and implementation, high interest rates on the investment portfolio, long payback period, the focus of financial institutions on the issuance of «short loans», usually consumer loans to the detriment of technological renewal of industrial sectors.

A whole set of measures is needed to resolve such contradictions. The main system-forming factors of this complex:

- creation of new organizational structures — networks, clusters, integrated corporations, including scientific, educational institutions and industrial enterprises, which combine innovation potential, resources, personnel, knowledge, information and competencies to create and transfer technologies;
- involvement of private financial institutions, marketing agencies, investment, brokerage companies, banks in the process of integration of scientific, educational and industrial sectors for

innovative development. Comprehensive investment, marketing and management support of commercialization and technology transfer projects is required;

- creation of effective tools and mechanisms for managing the integration processes of innovation networks [6, p. 79; 7, p. 345—347].

Conclusions. Ukraine needs to advance in the development of the market of technology transfer and commercialization of innovations in order to increase the level of its competitiveness: to form a database of scientific, technical, innovative projects; to establish the process of selection of innovative projects for state funding; develop a network of regional technology parks, business incubators, transfer support centers and technology commercialization. The concept of organizational and financial support for the effectiveness of the innovative component of Ukraine's competitiveness should be based on strategic, tactical and operational levels. To ensure a sustainable level of competitiveness of the country by increasing the innovation of the economy, it is advisable to introduce a set of measures to monitor threats at the stage of their emergence. That is why, among the tools for implementing the concept of organizational and financial support for the effectiveness of the innovation component of Ukraine's competitiveness should be: economic mechanisms (direct budget investments; concessional lending; integration with foreign institutions to finance innovation; increase the share of GDP aimed at financing innovation processes; an effective set of measures to attract international grants and household savings as investments to implement the concept of innovative development of the country's economy, etc.); organizational mechanisms (formation of integration clusters using the potential of education, business, government, public; state support for innovation infrastructure, etc.).

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