

Change Management in R&D-Quality Costs in Challenges of the Global Economy

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Abstract

The article considers the problems of R&D-quality costs management tools application in terms of entering new international markets. In the context of globalization of national economies, a key factor in the economic growth of any country is to ensure the sustainability and efficiency of innovation processes in enterprises. A necessary prerequisite for innovative activities of enterprises are R&D activities, for the conduct of which enterprises need certain resources, which ultimately identifies focus of research on R&D-quality costs management. The studied problem is widely discussed in Ukraine given the current geopolitical and socio-economic transformation. The article considers the current specifics of the problems that arise in enterprises which apply various tools to manage the cost of R&D quality in terms of entering new international markets. The main tools, features and problems in the process of R&D-quality costs management tools application, the level of support for innovation by business entities and research are analyzed. Trend models based on indicators of Ukrainian enterprises performing R&D activities are built.

Keywords 1

Private R&D, Research and Development Activities; Research and Development Costs; Quality Cost Management Tools, Entrepreneurship, International Markets, Business Entities.

1. Introduction

The current state of the global environment is undergoing continuous and dynamic changes, while the problem of depletion of material economic resources remains particularly relevant, forcing countries to apply non-standard innovative, and to some extent, radical solutions. The main focus of most countries remains on ensuring sustainable development, which in turn depends on maintaining constant growth in international markets for innovative products, goods, processes, and services. This indicates that the determining factor in the economic growth of any country is to maintain a consistently high level of innovation through research and development. In order to implement such state policy in the field of entrepreneurship as a driving force of innovation processes in a competitive environment, it is necessary to effectively manage available resources and costs of innovation.

The problem of applying cost management tools for research and development (which are the main component of innovation costs of economic entities) is especially important for Ukraine, which is determined by the adaptation to the requirements of the European Economic Area, the achievement of regulatory standards for its competitiveness innovative development of enterprises. Given these circumstances, Ukrainian enterprises should become highly efficient economic units that are able to

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ensure a stable high level of economic growth through the development and implementation of innovative products by choosing economically effective cost management tools that will maximize the economic results of research and development and turn them to extremely profitable and successful developments.

The purpose of this work is to analyze the features and problems of enterprises using cost management tools for research and development in terms of entering new international markets and select those tools that will maximize the economic and technological results of scientific developments and research for enterprises, industries and countries.

2. Analysis of recent research and publications

In the context of global transformations of the world economy, the tendency to actualize the problems of application and development of effective cost management tools is inherent in research and publications, both for countries with economies in transition and for developed countries. The main tools for managing R&D-quality costs are reflected in the works of many foreign scientists [1-3, 6, 8, 13-20, 22, 25-31, 36, 48, 56]. Among them are the most famous works: Shahsi Niyai [48], A. Henriksen [18], Afcha S. [1], Xin Jin [56], Kotter J.P. [25-31], A. Aristovnik [2], O. Limanli [36], O. Karahan [20], P. Dobrzansky [13], Erdal L. [14] and others. Among the Ukrainian authors who study the problems of managing R&D expenditures are the works of N. Chukhray [11], Berko A. [4], O. Bisikalo [7], L. Chyrun [12], I. Gerashchenko [16], O. Kasyanov [21], Kozyk V. [32], V. Krush [33], O. Kuzmin [35], S. Zhukevych [57] and others.

The value of cost management tools for research and development is revealed through the systematization of methods for estimating these costs, the calculation of performance indicators of this type of costs. Krush and Pashkov [33] divided the costs of R&D into internal and external for the company. The cost structuring mechanism is one of the methods of managing the efficiency of development and research costs. The process of structuring goes in search of the optimal ratio of component costs, which allows the company to achieve maximum financial results. Cost management aims to ensure control over the redistribution of enterprise resources intended for research and development, according to international standards.

The essence of the tools for managing the costs of enterprises for research and development is to constantly monitor the amount and structure of costs and ways to influence them. Cost management aims to reduce inefficient costs and prevent the impact of cost reduction on the deterioration of the quality of scientific and technical developments, underproduction of competitive innovative products, which is the result of development and research. Modern mechanisms for managing the cost of research and development are designed to achieve the planned level of competitiveness of enterprises in market conditions. The change in the cost structure caused by innovative processes will ensure greater cost efficiency of enterprises that actively participate in R&D [57].

A. Bin and others [6] through the implementation of fundamental analysis and evaluation of research projects proposed to manage the cost of research. The method makes it possible to choose the best combination of the proposed research projects according to their usefulness and to select each project separately according to the established criteria and restrictions (number of employees, time allocated for project implementation and implementation, budget). The method is designed for efficient use of resources allocated by the enterprise for development and research and, as a consequence, allow to eliminate inefficient costs.

The method proposed by M. Shahsi-Niyai, Torabi and Iranmanesh [48] is used in conditions of uncertainty of the enterprise budget and uncertain availability of resources required for the research project. This model is to identify the problem of organizing the project with the lowest costs in a crisis situation and the urgent need for savings, reducing all types of losses on the accumulation of resources. It is based on the ranking of scientific developments by the ratio of their costs and economic benefits as a result of implementation and adoption of R&D ultimate results (e.g. new product or process).

The project portfolio decision-making method involves allocating a limited set of resources for research and development in such a way as to balance risk and reward [3]. The problem of applying this method is the complex interdependence between research projects and available resources, which

complicates the choice of tools to find the optimal point between the level of costs and effectiveness of research, and the simultaneous management of several R&D using shared resources.

The state's support for innovation processes in enterprises is to provide them with resources, provide tax and personal benefits, which allows them to optimize the cost of research and development. There is a significant positive correlation between the intensity of research and development and the number of enterprises engaged in R&D activities. Creating a corporate network of such enterprises will help increase the efficiency of R&D [56].

Erdogan and Yamaltdinova [15] investigated the impact of R&D expenditures on the financial performance of Turkish firms in 2008-2017. It is established that the increase in R&D expenditures was a consequence of the increase in return on assets and equity. With this dependency, firms can change the share of R&D costs by purchasing additional assets.

Henriksen and Traynor [18] proposed a method for estimating R&D costs using scoring models for cost analysis. To manage the costs of research and development used a cost function that combines 2 factors - the value and cost of resources. The problem that arises in the process of applying this method is the reduction of scientific return and the return from the implementation of the program of scientific research and development (programmatic return).

Erdal and Geser [14] found a direct relationship between foreign direct investment on the level of R&D expenditure, the number of patents and the intensity of research and development on the example of 10 developing countries in Asia. R&D expenditure management under such conditions is possible by applying the method of cointegration and dynamic least squares. As foreign direct investment increased for the host country, R&D spending was reduced.

The cost management tool according to Limanley [36] is the influence on the determinants of enterprise costs for research and development. The problem with this method is that it can be effectively applied to the developer rather than at the planning stage. If the method is used by a large enterprise, then another problem of applying the method is the existence of a direct dependence of the market share of the enterprise on the level of R & D costs.

Afha and Lopez [1] with the help of a multi-nominal logistics model for estimating R&D costs as a result of a combination of internal and external research have established the modality of eliminating inefficient R&D costs. The main problem with this model is the uneven access to information on the demand for technological innovation and technical and legal barriers in the technology market.

The problems that arise in the application of the tool for managing R & D costs, which is to reduce the time from research to market entry of innovative products while maintaining a constant level of costs by dividing research into discrete stages, which can be performed sequentially or in parallel, are low level of automation, access to information and insufficient level of staffing [17]. Karahan [20] proposed a tool for managing R&D costs, which is the integrated development of innovative products or processes that are complementary to each other. The problem which arises in the application of this method is the insufficient level of technical equipment.

The volumetric data analysis model was used to assess the efficiency and cost management of R&D enterprises in ASEAN countries. A significant obstacle to the effective application of the method is the problem of lack of effective new technologies [13].

For countries with low technical efficiency, the tool for managing R&D costs is the reduction of research staff, the maintenance and salary of which is a significant share of R&D costs [2].

Gerashchenko [16] developed a mechanism for managing R&D costs by assessing the technical parameters of input resources and outputs, which avoids the cost of unpromising and inefficient research and development. Other analyzed tools for managing R&D costs are cooperation with venture firms, the creation and maintenance of research technology parks.

Chukhrai and others [11] developed a method for assessing the readiness of research and development results for transfer, using 5 criteria that were measures of the readiness of research products for commercialization. The level of technological analytical, patent readiness, the level of readiness on demand and the impact of R & D results on society were chosen as criteria for assessing the readiness of R & D results for transfer. In the developed model, the level of readiness on demand characterizes the level of market readiness for technology transfer. The impact on society takes into account primarily the level of technical and scientific progress resulting from the application of technology, as well as changes that have occurred as a result of the use of technology (process, product, service) in households. The authors pointed out that R&D results become a product when

they have a consumer value, which consists in the corresponding benefits and costs. Benefits and costs are two categories of economic evaluation of technologies that are interdependent. Cost-benefit analysis, which consists in calculating the net benefit by subtracting the amount of costs from the amount of benefits, is a necessary step before making management decisions.

Change management is the process of finding and solving problems [37, 43]. Managing change means moving from a problem state to a problem state. Three types of actions are involved in this process: transformation, reduction and application [3, 5, 45]. The goals and actions of transformation are related to the identification of the difference between two states: the problem and the solved problem [48, 52, 54]. Reducing goals refers to finding ways to eliminate this difference. The application of goals is associated with the activation of operators, which will eliminate this difference [49, 53].

However, the problems of applying cost management tools for research and development in terms of entering new international markets remain insufficiently studied.

3. Results

Based on a study of the features and problems of application of tools to reduce the cost of development and research used in developed countries, it is established that they are all based on state support for innovation processes [21]. In particular, the United States does not include R&D expenditures related to trade and operating activities to the amount of taxable income. In the United Kingdom, R&D costs are deducted from the cost of products (services). In France, an effective tool was to provide a tax credit for the increase in development and research costs.

In addition to these tools to reduce the cost of development and research, it was found that for a long time a fairly effective mechanism were depreciation and tax benefits, which allowed to cover from 10 to 20% of total R&D costs in the United States. As a result of this mechanism, companies in the United States have focused their resources on conducting research and development with a rapid return on capital [83].

There are 4 groups of international standards of the World Intellectual Property Organization, which also include methods for evaluating research and development, estimating the cost of research and management methods. WIPO has developed 52 normative documents that contain requirements for standardization of research and development, of which 50 are actual standards related to the processes of design and implementation of development, creation of industrial (design) model, and 2 annexes to these standards. These standards include requirements for the preparation of documentation for the processing of information on the use of industrial property of enterprises, the preparation and execution of patent information and patent documents, the creation and registration of documentation on trademarks [55].

In accordance with international and national standards for the evaluation of innovation and technological projects, including research and development, there are 4 methods of evaluation - revenue, market, cost and combined [32]. Evaluation of innovation and technological projects includes methods and tools that take into account various parameters of innovation activities of enterprises, including such a category as costs. It is in this direction - the analysis and evaluation of the costs of innovation projects, which in turn include the cost of research and development, using the cost method of evaluation.

Features of the application of cost management tools are given in Table 1.

Table 2 lists the advantages and disadvantages of tools and methods for managing R&D costs.

In 2015 in Ukraine, the amount of expenditures on research carried out by organizations at their own expense amounted to 12224.9 million UAH, including labor costs - 5483.0 million UAH, material costs - 2472.0 million UAH, capital costs - 340.8 million UAH, of which the cost of purchasing equipment - 285.5 million UAH.

In 2018 the total amount of expenditures for research in Ukraine at the own expense of organizations amounted to 16773.7 million UAH, including labor costs - 8553.0 million UAH, other current expenses - 7456.3 million UAH, capital expenditures - 764, UAH 4 million, of which the cost of purchasing equipment - UAH 588.0 million (State Statistics Service, 2020a).

Table 1

Application of tools and methods of R&D cost management

Method / Tool	The problem that arises	The explanation of the solution
Decision making on the project portfolio	Complex interdependencies between research projects and available resources and in the simultaneous management of several R&D using shared resources	Gives the opportunity to form an optimal set of innovative development projects, taking into account the availability of resources and the need for each project to maximize the efficient use of these resources and the results of complex projects
The method of scoring models of cost analysis for the evaluation of research projects	Reduction of scientific return and return from the implementation of the program of scientific developments.	Gives the opportunity to find reserves to reduce (eliminate) inefficient costs, without reducing the volume of research and development, the main task of which is to maintain and increase the competitiveness of the enterprise
Method of influencing the determinants of costs	Impossibility of application to the business entity which is not carrying out R&D, and is at a planning stage.	It allows you to use only factual information about costs in order to find reserves for their more efficient use and management.

Source: author's development based on Limanli (2015), Bhattacharia, Kumar, Kara (2011), Henriksen and Traynor (1999)

Table 2

Advantages and disadvantages of using tools to manage the costs of enterprises in the research and development in terms of entering new international markets

Method / Tool	Advantages	Disadvantages
Decision making on the project portfolio	Allows to form an optimum set of projects of innovative developments; Takes into account the availability of resources and the need for them in each project; Maximizes the efficiency of resource use and the results of complex projects	Complicates the choice of tools to find the optimal point between the level of costs and the effectiveness of scientific development.
The method of scoring models of cost analysis for the evaluation of research projects	Search for reserves to reduce inefficient costs; Maintaining a constant level of spending on research and development; Improving the competitiveness of the enterprise.	Is to reduce the cost of research and development in crisis situations, which reduces the efficiency of innovation.
Method of influencing the determinants of costs	Analysis of current R&D expenditures; Search for reserves for effective research and development cost management; Mobilization of new resources from the identified reserves of reduced costs; Reducing the share of unproductive costs (input resources that do not provide returns in the form of innovation processes or increasing competitiveness)	Provides evaluation, analysis and impact on R&D costs based on actual past costs. Occurs if the method is used in a large enterprise.

Source: author's development based on Limanli (2015), Bhattacharia, Kumar, Kara (2011), Henriksen and Traynor (1999)

Table 3 presents the dynamics of R&D expenditures during 2010-2019.

Table 3

Dynamics of R&D expenditures for the period 2010-2019 in Ukraine

Years	Expenditures for research and development - total, UAH million	Including execution of:			Share of research and development expenditures in GDP, %
		basic research, UAH million	applied research, mln UAH	scientific and technical (experimental) developments, UAH million	
2010	8107,1	2175,0	1589,4	4342,7	0,75
2011	8513,4	2200,8	1813,9	4498,7	0,65
2012	9419,9	2615,3	2023,2	4781,4	0,67
2013	10248,5	2698,2	2061,4	5488,9	0,70
2014	9487,5	2452,0	1882,7	5152,8	0,60
2015	11003,6	2460,2	1960,6	6582,8	0,55
2016	11530,7	2225,7	2561,2	6743,8	0,48
2017	13379,3	2924,5	3163,2	7291,6	0,45
2018	16773,7	3756,5	3568,3	9448,9	0,47
2019	17254,6	3740,4	3635,7	9878,5	0,43

Source: based on the State Statistics Service (2020a)

The dynamics of costs for research and development for the period from 2010 to 2019 is described by the linear equation $y = 1001.9x + 6061.5$. From the graph we can conclude that the volume of R&D expenditures increased throughout the study period and according to the trend, the positive growth dynamics is projected to continue. The coefficient of determination is $R^2=0.8714$, which indicates the presence of a close relationship and the continuation of the upward trend in future periods. With the help of the trend line the forecast for the next 3 periods is made. With the help of the trend line the forecast for the next 3 periods is made. The graph shows that, given the current trend, the total cost of research and development will increase in each of these three forecast periods.

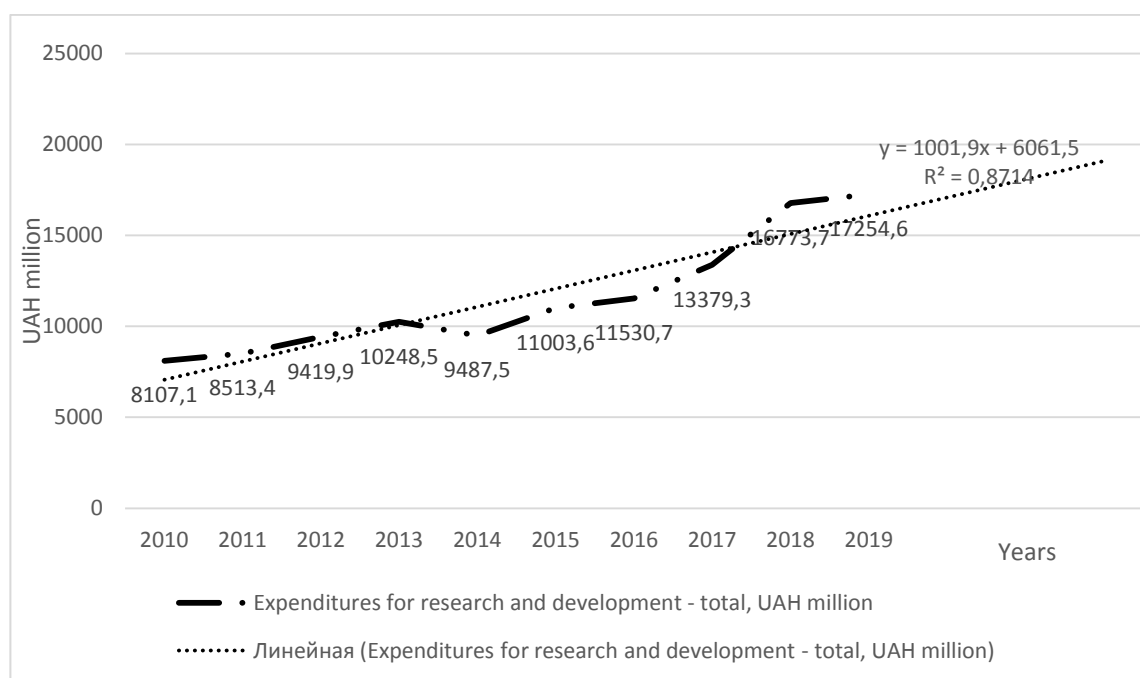


Figure 1: Dynamics of expenditures for research and development during 2010-2019

Source: based on the State Statistics Service (2020a)

The next step in analyzing the costs of Ukrainian enterprises in R & D is to study the dynamics of the share of components of the costs of enterprises in R&D. For this purpose, the share of components of R&D expenditures of Ukrainian enterprises for the period 2010-2019 is calculated. The results are given in table 4.

Table 4

Dynamics of the share of components of R&D expenditures for the period 2010-2019 in Ukraine

Years	Expenditures for research and development - total, UAH million	The share of implementation costs for:		
		basic research,%	applied research,%	scientific and technical (experimental) developments,%
2010	8107,1	26.82834	19.60504	53.56663
2011	8513,4	25.85101	21.30641	52.84258
2012	9419,9	27.76356	21.47794	50.7585
2013	10248,5	26.32776	20.11416	53.55808
2014	9487,5	25.84453	19.84401	54.31146
2015	11003,6	22.35814	17.81781	59.82406
2016	11530,7	19.30238	22.21201	58.48561
2017	13379,3	21.85839	23.64249	54.49911
2018	16773,7	22.39518	21.27318	56.33164
2019	17254,6	21.6777	21.0709	57.2514

Source: based on the State Statistics Service (2020a)

To better reflect the dynamics of relative indicators, it is advisable to give the dynamics of the share of R&D expenditure by their components graphically (Fig.2).

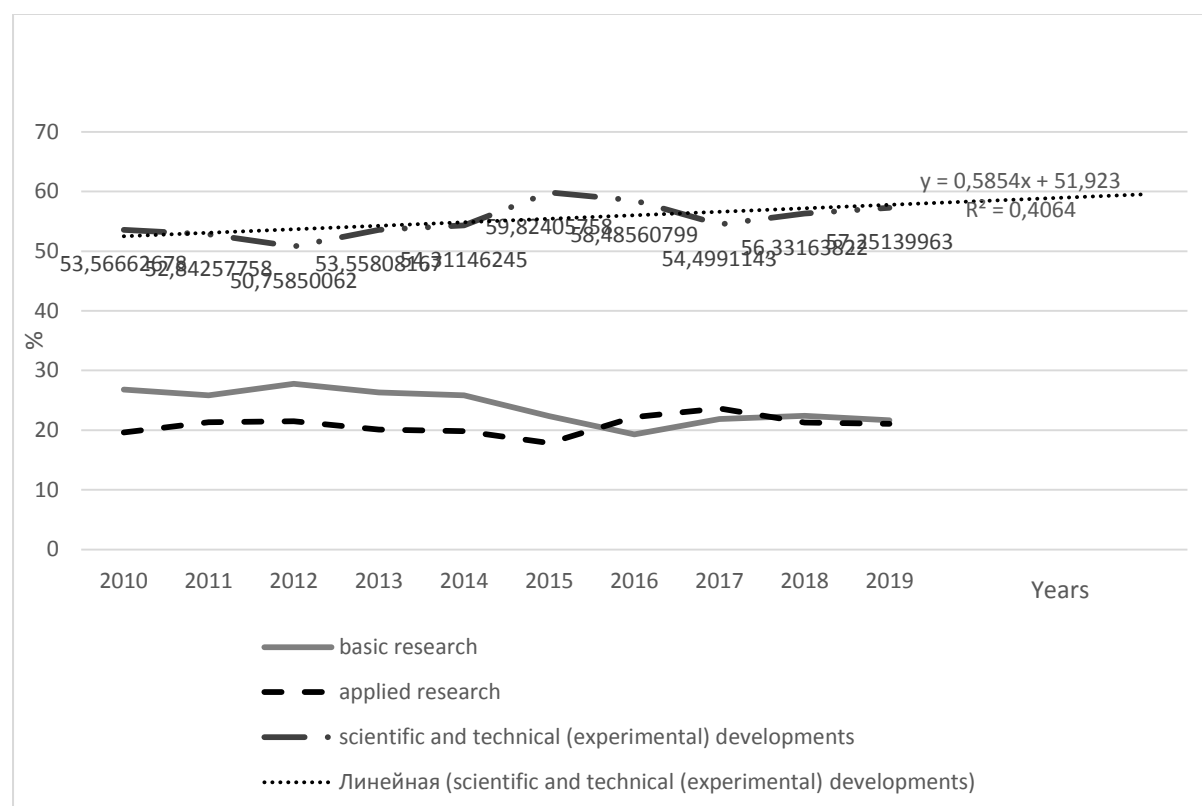


Figure 2: Dynamics of the share of component costs of Ukrainian enterprises in the R&D for the period 2010-2019

Source: author's development based on (State Statistics Service, 2020a).

Based on the graph data, we can conclude that the connection between the constructed trend line and the actual data on the dynamics of scientific and technical experimental developments, which were and remain the main and most significant element of R&D costs of Ukrainian enterprises. The value of the coefficient of determination $R^2 = 0.4064$ indicates that there is a low probability that this indicator will show positive growth dynamics in the next 3 years for which the forecast is made, it also indicates the existence of external factors that cause deviations from the trend line. Based on the time series of the share of scientific and technical (experimental) costs as part of the total costs of enterprises in the research and development, a trend line is constructed, which is described by the linear equation $y = 0.5854x + 51.923$. It is obvious that the basis and prerequisite for the implementation and development of research and development in enterprises of all industries in Ukraine is the growth of all components of the cost of research. The basis for scientific and technical experimental development is basic and applied research, in addition, all elements of research and development of enterprises are interconnected and complementary. It is the indicators of expenditures of Ukrainian enterprises on applied and basic research that did not have a clear pattern during the study period. This in turn led to their reduction and insufficient funding to maintain the regulatory and target level for enterprises, which resulted in uncertainty about the cost of the main element of research and development of enterprises - the cost of experimental development and the inability to accurately predict their future situation. periods.

Industrial enterprises are the largest centers of research and development among all business entities, and the most active users of the results of their own and external developments. Table 5 shows the dynamics of costs of industrial enterprises in the R&D for the period 2010-2019.

Table 5

Dynamics of R&D expenditures for the period 2010-2019 in Ukraine

Years	Research and development (R&D)		Including:			
	UAH million	In% to the total cost of innovation	internal		external	
			UAH million	In% to the total cost of innovation	UAH million	In% to the total cost of innovation
2010	996.4	12.4	818.5	10.2	177.9	2.2
2011	1079.9	7.5	833.3	5.8	246.6	1.7
2012	1196.3	10.4	965.2	8.4	231.1	2.0
2013	1638.5	17.1	1312.1	13.7	326.4	3.4
2014	1754.6	22.8	1221.5	15.9	533.1	6.9
2015	2039.5	14.8	1834.1	13.3	205.4	1.5
2016	2457.8	10.6	2063.8	8.9	394.0	1.7
2017	2169.8	23.8	1941.3	21.3	228.5	2.5
2018	3208.8	26.2	2706.2	22.2	502.6	4.1
2019	2918.9	20.5	2449.9	17.2	469.0	3.3

Source: based on the State Statistics Service (2020b)

To clearly demonstrate the change in R&D costs during the study period, it is advisable to display this time series graphically (Fig. 3).

According to the graph, we can conclude that the coefficient of determination $R^2 = 0.9225$, which indicates a close relationship between the time series of costs of industrial enterprises of Ukraine in the GDR with a trend line based on these data, which is described by the linear equation $y = 241.3x + 618.88$, and a forecast for 3 future periods. That is, the cost of industrial enterprises in the GDR will increase in the next 3 years (2020-2022). The correlation coefficient between the time series of internal costs of enterprises in the GDR and total costs is 0.99891, which indicates a direct relationship between these indicators, which leads to the conclusion that the total cost of industrial enterprises in the GDR by 99.891% depends on the cost of internal research and development. The graph shows that the volume of total and internal expenditures of enterprises on R&D tended to increase during the analyzed period.

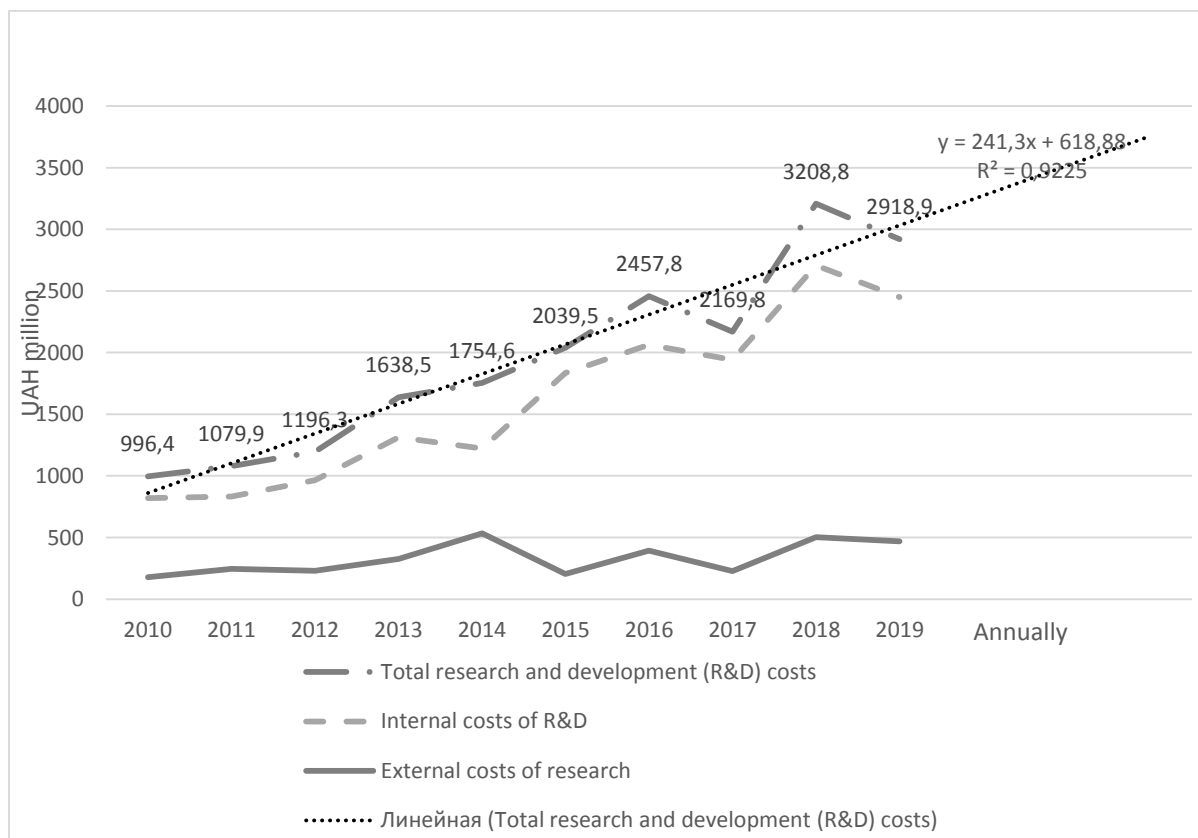


Figure 3: Dynamics of costs of industrial enterprises of Ukraine in the R&D for the period 2010-2019
Source: based on the State Statistics Service (2020b)

The correlation coefficient between the time series of total and external R&D expenditures is calculated, the value of the coefficient is 0.66211, which indicates a slight impact on the total R&D expenditures. Throughout the study period, the share of internal expenditures in total R&D expenditures exceeded 75%.

4. Conclusions

Thus, in the process of entering companies in new international markets there were problems with the use of cost management tools such as:

- 1) the problem of organizing the project with the lowest costs in a crisis situation and the urgent need for savings, reduction of all types of costs and accumulation of resources;
- 2) complex interdependencies between research projects and available resources, which complicates the choice of tools to find the optimal point between the level of costs and the effectiveness of scientific development;
- 3) reduction of scientific return and return from the implementation of the program of scientific developments (programmatic return);
- 4) the problem of inefficiency of cost management by the method of influencing the determinants of costs in the enterprise, which does not carry out actual research and development;

A study of statistical data on R&D expenditures by Ukrainian enterprises showed that research and development in the last 10 years have been the most important element in ensuring innovative and economic development of enterprises, and in the next 3 years their steady growth is projected. The costs of enterprises for applied and fundamental research were a determining factor in the implementation of scientific and technical developments by enterprises. However, the insufficient level of funding for basic and applied research and development had a negative impact on

experimental development. Thus, it is impossible to predict the dynamics of volumes and costs of experimental research in the next 3 years.

In contrast, during 2010-2019 there was a tendency to increase the total cost of research of industrial enterprises, which indicates the key role of Ukrainian industry in its innovative development strategy. The increase in total R&D expenditures at industrial enterprises was due to the growth of internal R&D expenditures of these enterprises, the share of internal expenditures in total R&D expenditures exceeded 75%.

The results of the study show that the cost of research and development is a key indicator that should be effectively managed in order to increase the volume of R & D and ensure higher rates of innovative development of enterprises.

Prospects for further research will be to identify ways to intensify and stimulate innovation in industry, as well as other sectors of the economy (services and agriculture) and methods of managing the costs of enterprises in R & D in terms of innovation development strategy.

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