

# Financial Mechanism for Managing the Environmental Innovation Development of the Economy in Ukraine

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## Abstract

The article substantiates the directions of improving a financial mechanism for managing the environmental innovation development of the Ukrainian economy. It presents an in-depth analysis of conceptual foundations of the formation of a system of principles, goals and criteria for ensuring the adequacy of a financial management mechanism with a special focus on the features of environmental innovation development. For optimal reallocation of a resource component, the necessity for systematic application of fiscal and credit management tools is justified. To ensure maximum growth of environmental innovation capacity of the economy the authors have improved a mechanism for developing an optimal set of target financing programs, analyzed the financial methods of managing the environmental innovation development of economy. The paper focuses on the nature and content of the concept "financial mechanism for managing the environmental innovation development of economy", which is proposed to be understood as a system of actions of financial methods and levers on the basis of relevant legal, information and regulatory support aimed at the most efficient development of the environmental innovation capacity of economy through optimal reallocation of the resource component of this potential. This enables, on the basis of a systematic analysis of financial relations that originate from environmental innovation development, to determine the main directions of their transformation under the influence of changes in the financial management mechanism. The subject of the research is the economic relations that arise between state and local government bodies and business entities regarding the allocation and reallocation of financial resources in managing the environmental innovation development of economy. In order to achieve the goal of the article, the authors have used the general scientific and special methods of cognition, fundamental provisions of general economic theory, the theory of economic development, evolutionary economics, economics and finance of nature management.

**Keywords:** environmental innovation development, financial management mechanism, financial instruments, financial incentives of environmental innovation development, efficient use of natural resource potential.

**JEL Classification:** Q5, Q55, Q57

## 1. Introduction

The task of ensuring the rational use of natural resources and reducing the eco-destructive impact of economy on the environment may not be solved only by limiting economic growth. The global experience shows that economic development, taking into account environmental restrictions, should be carried out exclusively on the basis of environmentally determined innovations.

Proceeding from the specifics of the processes of environmental innovation development, there is a need for its adequate, systematic and purposeful financial management. At the same time, the existing financial mechanism for managing the environmental innovation development of economy in Ukraine does not sufficiently fulfill the tasks assigned to it to stimulate the transition to more environmentally friendly technologies, and requires improvement.

The goal of the research is to develop the scientific and methodological approaches and practical recommendations for improving the financial mechanism for managing the environmental innovation development of economy.

The article uses the following research methods: system-evolutionary approach to understand objective laws of environmental innovation development, comparative and statistical analysis of environmental and economic consequences of technological shifts in the economy of Ukraine, dialectical method and method of logical generalization to study the operation of the financial mechanism for managing the environmental innovation development, system approach and logical analysis in the formation of the financial mechanism for managing the environmental innovation development of the Ukrainian economy, methods of economic and mathematical modeling of the incentive influence of financial instruments on the processes of environmental innovation development.

## **2. Research Background**

The problem of environmentally balanced economic development has become particularly urgent over the last century, when the rate of exchange with the environment has exceeded acceptable limits. On a global scale, the economic system has increased its potential and size to such an extent that it is difficult to talk about the natural environment as a system external to the economy. They have become equal in power, and in some cases the economic system even has an advantage over the environmental one. The nature of interaction between humanity and nature since the end of the 20th century shows the environment failure to resist the influence of human economic activity and, conversely, the ability of people to irreversibly change the key characteristics of the global ecology.

Thus, in particular, K. Hoffman as one of the founders of environmental economics has stated that there are good reasons to claim a qualitatively new stage of relations between society and nature, which is critically dangerous for civilization [9, p. 170].

It stands to reason that in the absence of conditions for dynamic equilibrium, the situation may end not only with a change in the pace of processes, but even with a complete change in their direction, in which development is blocked at all [10, p. 136]. This suggests that the environmentally sustainable development of the economy, if it is possible at all, may only take place under conditions that meet the requirements of the fundamental laws of the development of open stationary systems.

The study of the role of technological changes in the development of economy was conducted at different times and by different schools. The theory of innovative development of M. Tuhon-Baranovskyi and M. Kondratiev acquired the same classical features in the works of the Austrian economist I. Schumpeter. According to N. Kondratiev's "long wave theory", what constitutes innovation serves as a catalyst for increasing economic growth [1]. According to Schumpeter, technological innovations, which, according to their nature, make the economic system unbalanced, are, at the same time, a factor of a high degree of stability [1]. Here innovation as an economic category that has replaced the combination "new combination" is not a simple concept that denotes any innovation, but a new function of production, which is associated with such a factor in the development of the system as variability [4, 20]. Innovations here serve as a catalyst or impulse for qualitative changes in the economic system – economic development. But such development will not always be considered innovative.

The theory of evolutionary economic development provides a methodological basis for understanding the essence of innovation development, especially in terms of ensuring its long-term nature and environmental focus. This theory, according to V. I. Maievskyi's classification, has two concepts: the Schumpeter's concept, based on technological innovations; and institutional one, based on social institutions [15]. These two directions complement each other. The Schumpeter's concept focuses on changing technologies, while the institutional concept focuses on socio-economic and organizational conditions, which in turn determine technological changes [13].

Thus, at this stage of the study we may draw the following conclusion concerning the innovation development of economy: innovation means not a combination of unused means of production, but, on the contrary, other use of reserves of the means of production available in the national economy, the use of new technology. At the same time, there is a need for refocusing "old" industries and their infrastructure, and creating "new" industries with appropriate infrastructure. There is no doubt that this will be accompanied by a reallocation of resources for consumption between both "old", and "old" and "new" industries [11, 21].

These circumstances will be the first driving factor causing a change in the economic system structure that requires additional financial resources. Practice shows that it is necessary to study the issue of systematic improvement in the mechanism of financial management of innovative development processes, taking into account the environmental factor.

## **3. Research Design and Methodology**

### **3.1. Research Design**

#### **3.1.1. Essence of the environmental innovation development of economy**

A content-related analysis of economic development theories has enabled to assert that long-term environmentally sustainable economic development may only take place on the basis of a constant increase in the effective use of natural resources for the development of economic potential. It is established that the mechanism of innovative development plays a crucial role in this process, which determines the nature of economic evolution. In order to reflect the ability of economic potential of the national economy to be fully implemented on the basis of environmentally determined innovations, it is advisable to use the category "environmental innovation development of economy". It is understood as the process of developing the environmental innovation potential of the economy for ensuring the maximum possible growth of economic potential through more efficient use of its natural resource component.

Environmental innovation development necessarily assumes that the new, as a rule, does not grow out of the old, but appears along with it, displaces and replaces it, and this process is characterized by transition stages with a high degree of uncertainty – the so-called bifurcation points. In the absence of appropriate targeted impact, further processes may acquire an uncontrolled trajectory with negative environmental and economic consequences for society [7, 15].

Environmental innovation development as an objective process of interrelated progressive development of science, technology and production requires appropriate management in order to obtain the desired economic and environmental effect in the form of economic potential growth. At the same time, the selection of management tools should take into account the specifics of economic relations originating from environmental innovation development [6, 19, 22].

In this case, the long-term development of economy is mediated by changes in technological structures that makes it possible to fulfill the economic potential more fully.

A developing macro-level environmental-economic system has limited space, the limitedness of which is the result of both limited resources and limited scalability of this system. In such a limited economic space, there are economic entities that consume limited resources in their activities, using various ways of combining such resources – technologies [12, 17].

In accordance with this, it can be argued that modern industrial technologies have exhausted the available resource, reached the limit of their growth and completely filled the limited economic space. This, in fact, explains the mentioned environmental economic crisis – the boundaries of economic growth have coincided with the environmental boundaries. It is quite obvious that the rapid growth stage, which is sometimes called the “exponential stage” [2], may not continue indefinitely. With this development, we cannot avoid the rapid exhaustion of the limited resources of space, matter, and energy. It is clear that this does not mean the end of development. It is quite natural to predict that the environmental economic system, as a complex system, sooner or later must move to a state of equilibrium where there will be harmony with the environment. This for sure requires completely different technologies.

### **3.1.2. Structure of the financial mechanism for managing the environmental innovation development of economy**

The probability of the emergence of a new technology and the probability of resource consumption and maintenance, in a market economy are determined by the value of profitability (efficiency) of production based on such technology. In turn, profitability, based on the Schumpeter's theory, depends on the novelty of the way resources are consumed. The newer the technology is, the more cost-effective the production, which uses it, is. Accordingly, the older technology is characterized by worse resource consumption conditions, lower profitability that ultimately leads to the disappearance of production. Under these conditions, the emergence, growth, destruction and subsequent disappearance of technological aggregates become an evolutionary process, the driving mechanism of which is innovation [14, 16].

Innovative development at the micro level (at the level of a specific economic entity) may be described as a managed process of updating the nature of resource use based on the use of new technology.

At the macro level, innovative development is a complex process that includes changes in the main technologies and their corresponding forms of management, which are collectively aimed at effectively meeting needs at lower costs and resource saving at all its stages. It is this process of technology evolution that can ensure long-term environmental and economic development, in the sense of sustainable development of the national economy without harm to the environment.

The content of the process of greening innovative development, regardless of its specific understanding, which is usually carried out based on the goals of a particular study, is characterized by certain one-sidedness. One-sidedness in this case may be expressed either by the absolutization of environmental restrictions, when technological progress is considered only as an eco-destructive factor [8], or by the absolutization of the significance of technological progress, when the latter is considered as a panacea for all problems of environmental protection [5, 23].

In the first case, the main drawback of such views is their focus on the short-term optimization of environmental management. In other words [16], it is assumed to stay in the same technological mode for quite a long time.

In another approach, it is considered that such a problem is purely technical, and the creation of low-waste and resource-saving technologies eliminates it [18, 24]. However, the use of such technologies will prevent from achieving a synergistic effect, since they are used for each specific case, and do not provide for an indirect impact on other stages of the product manufacture and consumption process or on other production. To achieve the desired result, it is essential to make technological solutions aimed at changing the very nature of production process.

Thus, the need to ensure a dynamic balance between society and nature by creating a closed loop between economic activity and the natural conditions of its implementation has come to the agenda of economic development.

Environmental innovation development as an objective process of interrelated progressive development of science, technology and production requires its appropriate management in order to obtain the desired economic and environmental effect in the form of economic potential growth. At the same time, the selection of management tools should take into account the specifics of economic relations originating from environmental innovation development.

Thus, the conducted analysis enables to formulate the three synthesized definitions that characterize the logic of approaches to the definition of the category of financial mechanism for managing the environmental innovation development of economy.

The first one is the definition of the concept of financial mechanism for managing innovative development, which most corresponds to the internal content of such development – a set of actions of financial instruments and methods as a means of implementing the state's financial policy aimed at expanded reproduction of innovations in the economy.

The second one is the definition of the concept of the financial mechanism of greening – a set of actions of methods and levers for the formation and use of financial resources to achieve the goal of greening the economy .

The third is an integral definition that characterizes the financial mechanism for managing ecological and innovative development of the economy – a system of actions of financial methods and levers based on appropriate legal, informational and regulatory support aimed at the most effective development of environmental innovation potential by optimal reallocation of the resource component of such potential (Fig. 1).

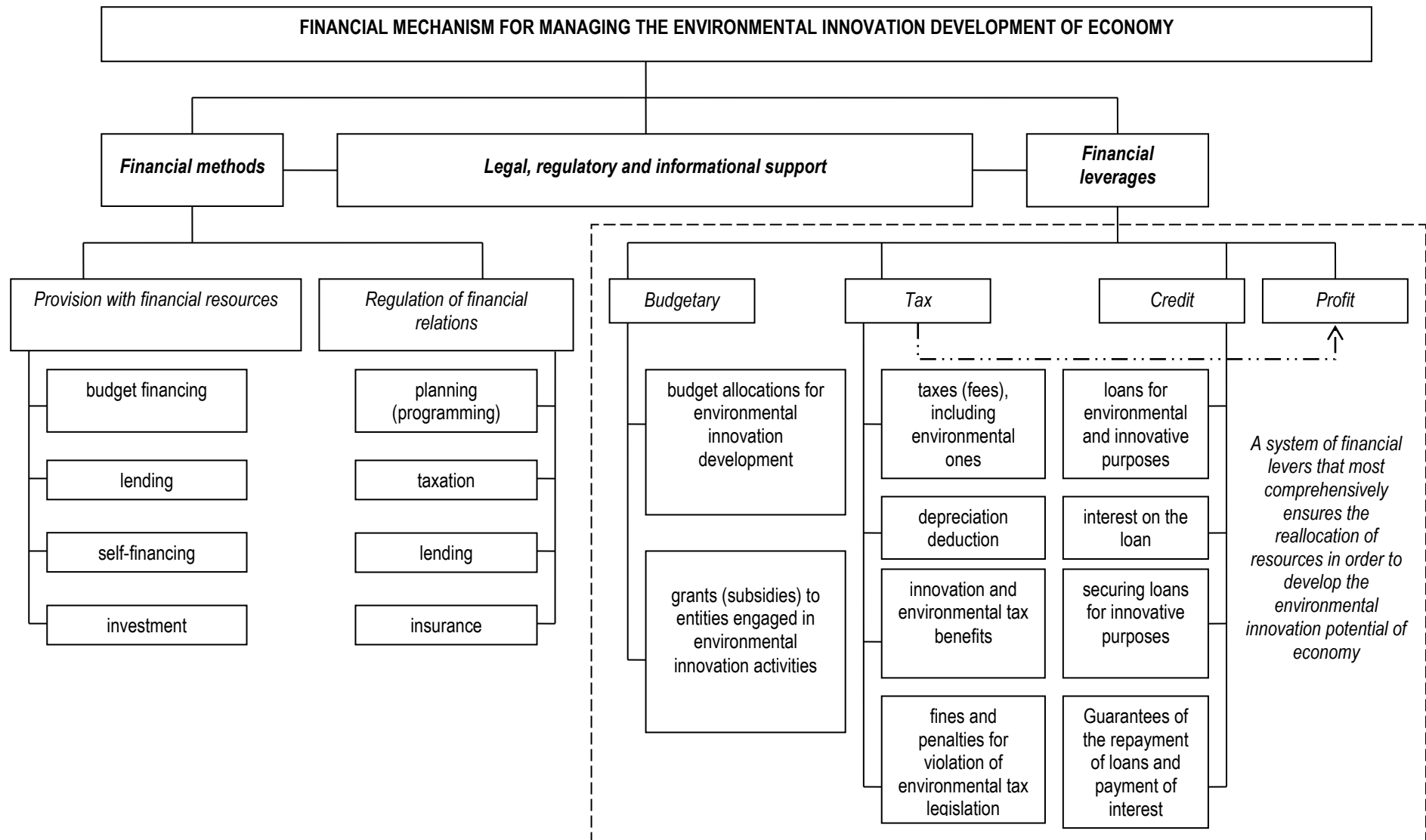


Figure 1 – Structure of a financial mechanism for managing the environmental innovation development of economy

Source: Authors' presentation

At the same time, the concepts of financial methods and levers are used in their common sense.

Financial methods are the ways financial relations influence economic processes. We divide all financial methods into methods of ensuring the environmental innovation development, which reflect the ways of providing the relevant processes with the necessary financial resources, and methods of regulating environmental innovation development – the methods of purposeful influence on such processes. The methods of financial support include budget financing of environmental research, crediting the introduction of environmentally determined innovations in production, investment and self-financing of their implementation. The methods of regulation include planning (including programming) of processes of environmental innovation development, taxation of production in order to stimulate the implementation of environmentally determined innovations, appropriate credit regulation and environmental insurance.

Financial leverages are the instruments used during the application of a specific financial method. In this case, we distinguish between budget, tax and credit levers, as well as allocate profit as the main motivational incentive lever and a tool for evaluating the implementation of environmental innovation development.

The main budget tools for managing the environmental innovation development include budget allocations for environmental and innovative purposes, grants to entities engaged in environmentally determined innovations. Tax tools include taxes and fees, including those of an environmental nature, innovative and environmental tax incentives, fines and penalties for violations of environmental legislation. Credit levers are loans for environmental and innovative purposes, interest on these loans, loan support and guarantees of repayment of loans for environmental and innovative purposes.

Therefore, radical changes in consumption and production methods are urgently needed to meet the growing needs of the population. Consequently, the priority is a complete transformation of the economic system to meet growing needs without loss to the environment rather than purely environmental measures. Moreover, such transformation should be carried out using endogenous mechanisms inherent in the economic system, which at the same time do not contradict the laws of natural development.

The only way to solve this problem is the environmental innovation development of economy, which is mediated by a gradual change in technological mode at the macro level of an economic system and specific production technology at a micro level, and results in efficiency gains of eco-economic system without additional resources.

Thus, innovative development sufficiently meets the requirements of qualitative changes in the nature of operation of the modern economic system both on a national and global scale. Ensuring the economy development on the basis of environmentally determined innovation production should be a decisive step towards the formation of a strategy for environmentally sustainable economic development. But here there are a number of problems that objectively arise from the essence of the environmental innovation development of economy and act in a certain sense as its nodal points. The main serious problem is the institutional provision of appropriate technological changes.

### **3.1.3. System of goals of the financial mechanism for managing the environmental innovation development of economy**

The problem of restructuring the management system is predetermined by the fact that the contours of economic relations, which have determined the flows of resource reallocation, are destroyed at the points of bifurcation. Accordingly, the previous system of economic assessments, which have mediated the processes of resource allocation and technological changes, as well as the entire mechanism for initiating and implementing structural changes in the economy are also collapsing. Thus, the task of developing an adequate financial mechanism for managing the environmental innovation development is almost the most important condition for ensuring sustainable economic development.

In general, the systemic restructuring of the financial mechanism for managing the environmental innovation development of economy should be based on solving a set of financial and economic problems: searching for and purposefully stimulating priority areas of economic development; implementing state support for long-term investments in new, more environmentally friendly technologies; forming tax policy on market conditions and taking into account the environmental and innovative nature of development; reforming the credit sector based on the operation of relevant banking institutions; financial support for the dissemination of innovative environmental technologies [8].

The system of financial management of environmental innovation development should ensure the purposefulness of the processes that mediate it. The environmental innovation development will only perform its functions when its internal processes are aimed exclusively at achieving the goals of environmental evolution and economic efficiency.

Therefore, the next principle should be the principle of target orientation of elements of the financial management mechanism – compliance of the selected means of financial incentives with the developed system of goals (Fig. 2).

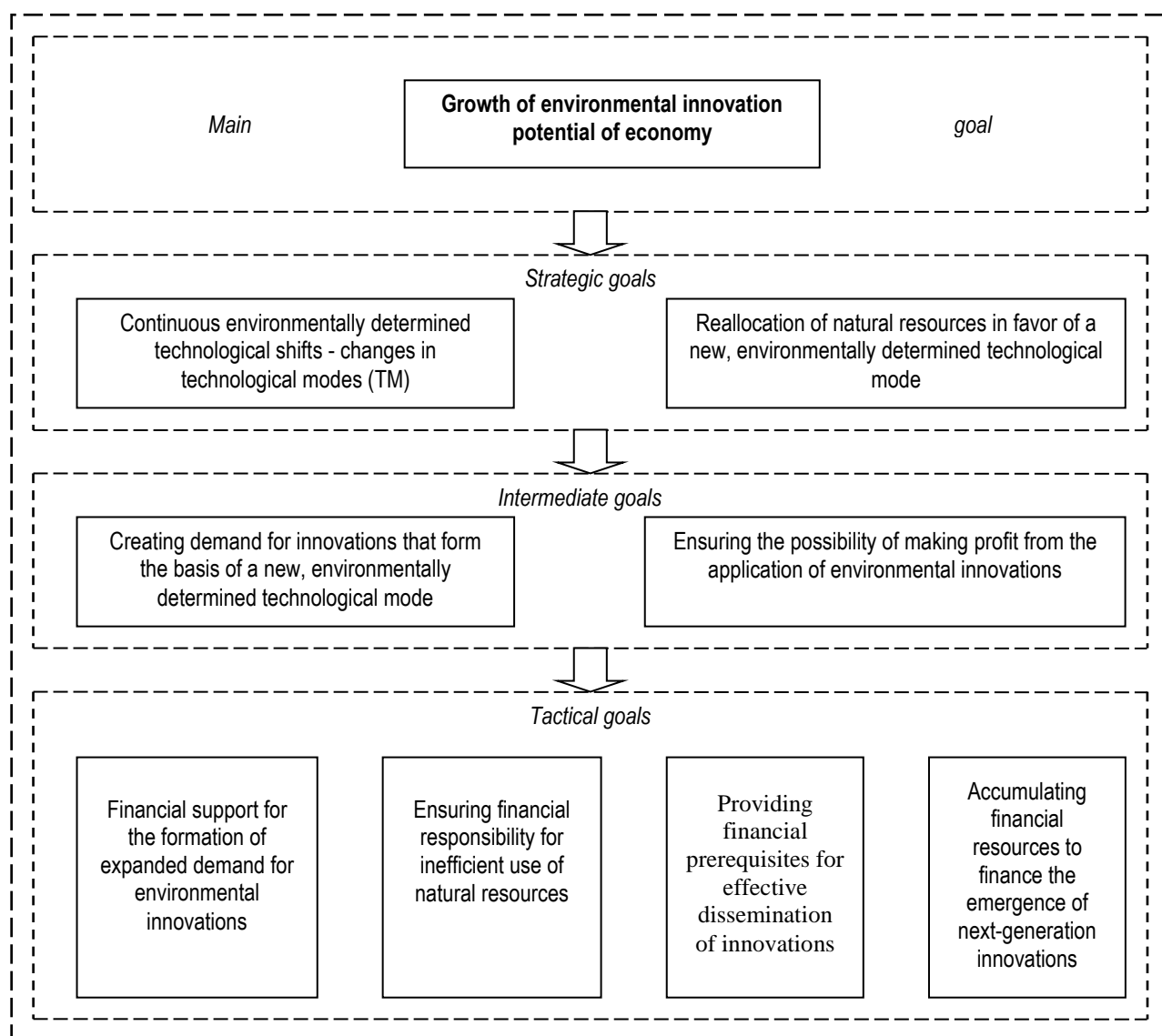


Figure 2 – System of goals of the financial mechanism for managing the environmental innovation development of economy

Source: Authors' presentation

The development of a system of goals in this case provides for the formation of a set of goals for managing the environmental innovation development of economy at various hierarchical levels, differing in both time and space parameters.

### 3.2. Financial methods of managing the environmental innovation development of economy

Indirect financial management methods include mainly tax and monetary policy measures. The main distinguishing characteristic of indirect methods as of today is the absence of any restriction on the economic independence of entities, if, for example, the payment of taxes or interest on loans is not considered as a restriction on the freedom of economic activity. Indirect financial management methods are more universal than direct ones, and are aimed not at regulating a particular process or entity, but at creating a common economic environment. Therefore, it is more appropriate to the goals of environmental innovation development based on market relations.

Closely related to the principle of economic independence is the principle of socio-economic justice, designed to ensure the same operating conditions for the same subjects of the process of environmental innovation development. The fact is that most of the tools and methods of financial incentives that are in effect today are selective, aimed at providing significant benefits to specific subjects of economic relations without proper justification that leads to the emergence of unequal economic conditions and social tension in society.

The main requirement of the principle of socio-economic justice should be a certain uniformity of objects of management. Such requirement may only be met if the financial mechanism is universalized and unified, mainly by implementing indirect management methods and improving their application.

To solve such problems, it is proposed to use a relative indicator that would characterize the ratio of the potential growth achieved and the resources spent for this purpose as a criterion for evaluating the effectiveness of the financial mechanism for managing environmental innovation development.

Thus, based on the analysis of the principles of financial incentives for environmental innovation development, it is advisable to allocate from the totality those that provide a systematic approach to the development of a financial mechanism for managing the environmental innovation development of economy and most complete account of the characteristics of the control object (Table 1).

Table 1 – Principles of financial incentives for the environmental innovation development of economy

Principle	Content of the principle
Systematically	ensuring the systemic impact of the applied elements of the financial management mechanism on the entire system of environmental innovation development
Adequacy	ensuring that the tools and levers used and the results of their application correspond to the key characteristics of processes originating from environmental innovation development
Economic feasibility	ensuring the economic efficiency of the use of financial instruments, when the national economic costs for such use do not exceed the positive effect obtained or the amount of losses avoided
Targeting	ensuring the compliance of the selected financial incentives with the established system of environmental innovation development goals
Temporal orientation	ensuring long-term sustainability of environmental innovation development
Economic independence	ensuring the combination of national goals of the environmental innovation development of economy with private freedoms of business entities
Social and economic justice	ensuring equal operating conditions for the same participants in the process of environmental innovation development on the basis of appropriate unification of the tools used

Source: Authors' presentation

### 3.3. Methodology for taking into account the difference in the levels of efficiency of natural resource potential use between the applied production technologies

Since innovations as a result of the implementation of innovative potential are potentially able to meet these requirements in the course of environmental innovation development, the management system of such development should facilitate the updating of such potential opportunities.

Currently, the achievement of these goals is ensured by taking into account the difference in the levels of efficiency of natural resource potential use between the applied production technologies.

The mechanism for such accounting is based on the application of the corresponding correction factor ( $k$ ) when determining the amount of corporate income tax according to the formula below:

$$IT_t = I_t * R * k_t, \quad (1)$$

where  $IT_t$  is the amount of income tax accrued in the period  $t$ , US dollars;

$I_t$  is the amount of income before tax in the period  $t$ , US dollars;

$R$  is income tax rate;

$k_t$  is adjusting factor in the period  $t$ .

In this case, the adjusting factor is intended to increase the amount of corporate income tax if the actual profit received is lower than the potential one in the case of the most effective use of the natural resource potential. The standard level of such efficiency for each specific production will be the most adequate efficiency of using the natural resource potential provided by the most innovative (currently existing) technology of the corresponding production [11].

In our opinion, the quantitative expression of the criterion for determining the ecological and innovative level of production, based on the need to take into account both the environmental innovation components of such efficiency, should be the indicator of the share of costs for natural resource use in the total cost of production, calculated by the formula below:

$$\alpha_t = \frac{C_{pt} + P_{pt} + P_{plt}}{Pr_t}, \quad (2)$$

where  $C_{pt}$  is costs of purchasing mineral resources that are included in the total cost of production in the period  $t$ ;

$P_{pt}$  is payments for the use of natural resources (for example, water), which are included in the total cost of production in the period  $t$ ;

$P_{plt}$  is payments for pollution included in the total cost of production in the period  $t$ ;

$Pr_t$  is total cost of production in the period  $t$ .

Therefore, the adjusting factor should reflect the following ratio:



$$k = \frac{P'_a}{P_a}, \quad (3)$$

where  $P_a$  is the actual amount of profit received;

$P'_a$  is the potential amount of profit, based on the current best level of the share of costs for natural resource use in the total cost of production and the actual profitability of production, calculated by the following formula:

$$P'_a = \frac{C_p + P_p + P_{pl}}{\alpha_n} * R_a. \quad (4)$$

In this case,  $Pf_a$  is the actual level of profitability of production, calculated by the following formula:

$$Pf_a = \frac{P_a}{Pr_a}, \quad (5)$$

where  $Pr_a$  is the actual total cost of production;

As the final result we obtain:

$$k_t = \frac{\alpha_t^a}{\alpha^n}, \quad (6)$$

where  $\alpha^n$  is the baseline share of costs for natural resource use in the total cost of production (the best one at the moment);

$\alpha_t^a$  is the actual level of the share of costs for natural resource use in the total cost of production in the period  $t$ .

The proposed method should be implemented using the following algorithm.

1.

For specific production, based on the analysis of statistical data and taking into account environmental factors, the period of updating the main technology ( $T_i$ ) is determined. At the same time, it is predicted that an eco-innovative technology will appear during this period, which is characterized, in particular, by a lower share of costs associated with the use of natural resources in the total cost of production. In order to ensure comparability of options, the analysis horizon  $T$  is assumed to be equal to  $2T_i$ .

2. When such an eco-innovative technology is introduced, the average value of the share of costs associated with the exploitation of natural resources in the total cost of production, weighted by the amount of such costs, is calculated for the entire period  $T$

$$\bar{\alpha} = \sum_{t=1}^T \alpha_t * \gamma_t, \quad (7)$$

where  $\alpha_t$  is the share of costs associated with the exploitation of natural resources in the total cost of production in period  $t$ , calculated by the formula (2);

$\gamma_t$  – weighting parameter in the period  $t$ , calculated by the formula

$$\gamma_t = \frac{C_{pt} + P_{pt} + P_{plt}}{\sum_{t=1}^T (C_{pt} + P_{pt} + P_{plt})}, \quad (8)$$

where  $T$  is the duration of production operation.

The resulting value  $\bar{\alpha}$  is taken as the base value for any similar production ( $\alpha^n$ ).

3. Starting from the period  $t = T_i + 1$ , for similar production, the amount of actual taxable profit ( $l_t$ ) and the actual value of the share of costs for natural resource use in the total cost of production ( $\alpha_t^a$ ) is determined.

4. The correction factor ( $k_t$ ) is calculated based on the ratio of the actual value and baseline share of costs for natural resource use in the total production cost of this production ( $\alpha^n$ ).

5. We calculate the amount of tax on profit in the respective period  $t$ .

The level of tax burden on production when applying this method will depend simultaneously on the degree of implementation of two components of the environmental innovation potential of economy: the level of novelty (innovation) of production technology and the level of consumption of natural resources (environmental friendliness).

As can be seen, the proposed scheme for taking into account the features of the environmental innovation nature of economic development in the application of tax management tools for such development ensures the achievement of the goal of system incentives for the transition to more environmentally efficient innovative technologies to meet public needs.

It is important to work out the mechanism for granting preferential loans: preferential loans should be provided only to those entities that are able to use them effectively and repay them on time. In addition, the provision of preferential loans should

have certain time limits, that is, they should be used only in those periods when it is necessary for accelerated economic development. This ensures the principles of adequacy and temporary compliance of the applied management tools.

At the same time, preferential loan support for environmental innovation development processes should be provided subject to the application of the general program-target financing method. In this case, the amount of credit benefit that is a reduction in interest for using loans should be determined in the form of a range of interest rates within the NBU discount rate, based on the priority of a specific program objective to achieve the main goal (Table 2).

At the same time, we should not forget that an important criterion for crediting innovative processes is its long-term nature. The specifics of innovation development require an extension of the terms of use of the attracted resources in comparison with the usual areas of capital investment, and therefore the entire financial mechanism for providing loans for such development should be transformed to ensure the economic efficiency of long-term lending.

Table 2 – Determination of preferential interest rates for credit support of environmental innovation development

Goal rank	Range of priority values	Range of interest rates, %
1	0.91 – 1	0 – 2
2	0.81 – 0.9	
3	0.71 – 0.8	2 – 4
4	0.61 – 0.7	
...	...	...
m	0 – 0.1	8 – 10

Source: Authors' presentation

The reluctance of commercial banks to invest in environmental innovation projects is related to the priority of meeting the needs of the visible future that requires the creation of a mechanism that would form the economic interest of investors in long-term effects.

The difference between the program-target method of budget financing and other forms and methods is the unconditional focus on the final result, and the formulation of the final result should precede all other stages of program formation and implementation. In fact, we are talking about planning “from the end”, when we first define the strategic goal of the program – a specific result that can be measured, and then plan the implementation of lower-level goals that should ensure the achievement of the main goal.

The process of implementing the program-target method of financing the environmental innovation development should take place systematically under the formation of a financial mechanism for managing such development.

In accordance with the new environmental innovation paradigm of the national economy development, a characteristic feature of the model of financing such development should be a systematic combination of the program-target method of financing specific projects with the implementation of general financial incentives, as opposed to simple financial support.

## 4. Empirical Results Analysis

### 4.1. Analysis of production indicators based on the environmental innovation technology

For analysis, we will use data from an innovation project submitted to the state innovation company for funding. The project compares the use of two different technologies for reducing gas pressure at gas distribution stations in the gas industry: traditional technology is based on throttling valves – direct pressure regulators; innovative technology is based on jet turbo expanding assemblies. The advantages of innovative technology, in addition to lower operating costs, also include the use of secondary energy resources that reduces environmental pollution and the need for primary energy resources.

In all cases, the analysis horizon is 14 years in order to ensure the comparing of the options, since as of today, on average, the period of updating the main technology of this production type, taking into account environmental factors, is about 7 years. It is at the end of this period of time that the company should make the transition to environmental innovation technology. Accordingly, starting from the 8th year of the production operation, the proposed tax incentive mechanism begins to operate.

Thus, first we will determine the production indicators based on the environmental innovation technology (Table 3). Currently, the environmental innovation technology is characterized by a reduction in the cost of natural resources and payments for pollution, both in absolute terms and in relation to the total cost of production – the total cost of manufacture. Then, based on the data on the total cost of production and costs associated with the use of natural resources using the formulas (2), (7) and (8), we will determine the weighted average value of the share of costs associated with the use of natural resources in the total cost and take it as the base value (Table 4). So, we obtain  $\alpha^{\text{н}} \approx 0.32$ . In further calculations, the actual values of the share of costs associated with the use of natural resources in the total cost of production, respectively, with the replacement of technology and without such replacement, will be compared with the obtained standard values.

The next step will be the analysis of production indicators, provided that the replacement of technologies does not occur (Table 5). The existing dynamics of income and total cost of production is determined by changes in production volumes: during the first 4 years, production volumes increase, from the 4th to the 8th year they remains at the maximum level, starting from the 9th year production volumes decrease. In addition, due to the depreciation of fixed assets, starting from the 10th year, there is an increase in current production costs, including the cost of natural resources. As we can see, if the annual production volumes and the corresponding amounts of income are equal, the use of environmental innovation technology enables to more fully realize the economic potential that is to obtain more profit by reducing the environmental capacity of production.

Thus, in this case, the financial mechanism for managing the environmental innovation development in order to prevent inefficient use of natural resource potential should be aimed at stimulating the replacement of technologies from the 8th year. Thus, the principles of adequacy, time and economic independence of business entities are taken into account (see Table 1). They determine the degree of adaptability of the financial mechanism for managing the environmental innovation development.

In case of replacement of the technology, starting from 8th year production operates based on the innovative technology that reduces the consumption of natural resources and environmental pollution (Table 6). Therefore, it is essential to consider a corresponding reduction in production volumes and increase in fixed costs caused by the commissioning of new equipment.

According to the developed methodology, in both options (technology replacement and non-replacement) the actual values of the share of costs associated with the use of natural resources in the total cost of production are determined starting from the 8th year. The ratio of actual and normative values determines the adjusting factor used to adjust the accrued amount of income tax in a given year.

Table 3 – Dynamics of production indicators based on environmental innovation technology, thousand US dollars

Indicators	Years														Sum of indicators (given at the beginning of the 1st year)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Income	2,200.00	2,350.50	2,573.60	2,718.80	2,718.80	2,718.80	2,718.80	2,718.80	2,669.20	2,570.70	2,450.30	2,320.30	2,190.10	2,010.50	18,504.56
Total cost of production, including <i>cost of purchased natural resources and payment for the use of natural resources</i>	1,872.00	1,816.87	1,829.58	1,824.20	1,760.14	1,710.12	1,671.08	1,640.59	1,590.60	1,533.58	1,467.93	1,399.08	1,331.32	1,236.78	12,442.44
<i>payments for pollution</i>	440.00	470.10	514.72	543.76	543.76	543.76	543.76	543.76	533.84	519.28	499.91	478.12	455.81	422.61	3,721.38
Income before tax	6.60	7.05	7.72	8.16	8.16	8.16	8.16	8.16	8.01	7.79	7.50	7.17	6.84	6.34	55.82
Total production profitability	328.00	533.63	744.02	894.60	958.66	1,008.68	1,047.72	1,078.21	1,078.60	1,037.12	982.37	921.22	858.78	773.72	6,062.12
Share of costs associated with the exploitation of natural resources in the total cost of production	18%	29%	41%	49%	54%	59%	63%	66%	68%	68%	67%	66%	65%	63%	
	0.24	0.26	0.29	0.30	0.31	0.32	0.33	0.34	0.34	0.34	0.35	0.35	0.35	0.35	

Source: Authors' presentation

Table 4 – Determination of the weighted average share of costs associated with the exploitation of natural resources in the total cost of production

Indicators	Years														Amount
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Costs associated with the exploitation of natural resources, thousand US dollars. ( $C_p + P_p + P_3$ )	446.60	477.15	522.44	551.92	551.92	551.92	551.92	551.92	541.85	527.07	507.41	485.29	462.64	428.95	7,158.99
Share of costs associated with the exploitation of natural resources in the total cost of production ( $\alpha_t$ )	0.24	0.26	0.29	0.30	0.31	0.32	0.33	0.34	0.34	0.34	0.35	0.35	0.35	0.35	
$\gamma_t$	0.06	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.06	0.06	
$\alpha_t \cdot \gamma_t$	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	<b>0.32</b>

Source: Authors' presentation

Table 5 – Dynamics of production indicators without technology replacement, thousand US dollars

Indicators	Years														Sum of indicators (given at the beginning of the 1st year)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Income	2,200.00	2,350.50	2,573.60	2,718.80	2,718.80	2,718.80	2,718.80	2,718.80	2,669.20	2,570.70	2,450.30	2,320.30	2,190.10	2,010.50	18,504.56
Total cost of production, including <i>cost of purchased natural resources and payment for the use of natural resources</i>	2,041.55	2,010.63	2,052.49	2,067.05	2,007.57	1,961.13	1,924.87	1,896.56	1,843.46	1,780.70	1,706.70	1,628.09	1,550.14	1,439.99	14,111.09
<i>payments for pollution</i>	616.00	658.14	720.61	761.26	761.26	761.26	761.26	761.26	747.38	726.99	699.87	669.37	638.13	591.66	5,209.93
Income before tax	11.00	11.75	12.87	13.59	13.59	13.59	13.59	13.59	13.35	12.98	12.50	11.95	11.40	10.57	93.03
Total production profitability	158.45	339.87	521.11	651.75	711.23	757.67	793.93	822.24	825.74	790.00	743.60	692.21	639.96	570.51	4,393.47
Share of costs associated with the exploitation of natural resources in the total cost of production	8%	17%	25%	32%	35%	39%	41%	43%	45%	44%	44%	43%	41%	40%	
Adjusting factor	0.31	0.33	0.36	0.37	0.39	0.40	0.40	0.41	0.41	0.42	0.42	0.42	0.42	0.42	
								1.28	1.29	1.30	1.31	1.31	1.31	1.31	
Income tax at the rate of 25%	39.61	84.97	130.28	162.94	177.81	189.42	198.48	205.56	206.44	197.50	185.90	173.05	159.99	142.63	1,098.37
Net profit (25%)	118.84	254.90	390.84	488.81	533.42	568.26	595.45	616.68	619.31	592.50	557.70	519.16	479.97	427.88	3,295.11
Income tax at the rate of 25% taking into account the adjusting factor	39.61	84.97	130.28	162.94	177.81	189.42	198.48	262.99	266.76	257.00	242.98	226.78	209.92	186.78	1,236.90
Net profit (25% taking into account the adjusting factor)	118.84	254.90	390.84	488.81	533.42	568.26	595.45	559.25	558.98	532.99	500.62	465.44	430.04	383.72	3,156.57

Source: Authors' presentation

Table 6 – Dynamics of production indicators with technology replacement, thousand US dollars

Indicators	Years														Sum of indicators (given at the beginning of the 1st year)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Income	2,200.00	2,350.50	2,573.60	2,718.80	2,718.80	2,718.80	2,718.80	2,200.00	2,350.50	2,573.60	2,718.80	2,718.80	2,718.80	2,718.80	18,689.24
Total cost of production, including <i>cost of purchased natural resources and payment for the use of natural resources</i>	2,041.55	2,010.63	2,052.49	2,067.05	2,007.57	1,961.13	1,924.87	1,872.00	1,816.87	1,829.58	1,824.20	1,760.14	1,710.12	1,671.08	14,297.65
<i>payments for pollution</i>	616.00	658.14	720.61	761.26	761.26	761.26	761.26	440.00	470.10	514.72	543.76	543.76	543.76	543.76	4,725.94
Income before tax	11.00	11.75	12.87	13.59	13.59	13.59	13.59	6.60	7.05	7.72	8.16	8.16	8.16	8.16	80.77
Total production profitability	158.45	339.87	521.11	651.75	711.23	757.67	793.93	328.00	533.63	744.02	894.60	958.66	1 008.68	1 047.72	4,391.59
Share of costs associated with the exploitation of natural resources in the total cost of production	8%	17%	25%	32%	35%	39%	41%	18%	29%	41%	49%	54%	59%	63%	
Adjusting factor	0.31	0.33	0.36	0.37	0.39	0.40	0.40	0.24	0.26	0.29	0.30	0.31	0.32	0.33	
								0.75	0.82	0.89	0.95	0.98	1.01	1.03	
Income tax at the rate of 25%	39.61	84.97	130.28	162.94	177.81	189.42	198.48	82.00	133.41	186.01	223.65	239.67	252.17	261.93	1,097.90
Net profit (25%)	118.84	254.90	390.84	488.81	533.42	568.26	595.45	246.00	400.22	558.02	670.95	719.00	756.51	785.79	3,293.69
Income tax at the rate of 25% taking into account the adjusting factor	39.61	84.97	130.28	162.94	177.81	189.42	198.48	61.26	109.71	166.32	211.89	235.33	254.85	270.90	1,068.22
Net profit (25% taking into account the adjusting factor)	118.84	254.90	390.84	488.81	533.42	568.26	595.45	266.74	423.92	577.70	682.71	723.33	753.83	776.82	3,323.37

Source: Authors' presentation

## 4.2. Example of calculating the scheme for adjusting the amount of income tax

For example, we will consider the adjustment scheme in the 12th year for both options:

for the option without replacing the technology:

1) income before tax –  $I_{12} = 692.21$  thousand US dollars.

2) actual value of the share of costs associated with the use of natural resources in the total cost of production –  
 $\alpha_{12} = (669.37 + 11.95) / 1,628.09 \approx 0.42$ ;

3) adjusting factor –  $k_9 = 0.42/0.32 = 1.31$ ;

4) accrued income tax amount  $IT_{12} = 692.21 * 0.25 = 173.05$  thousand US dollars;

5) accordingly, the adjusted amount of income tax  $IT'_{12} = 173.05 * 1.31 = 226.78$  thousand US dollars.

For the technology replacement option:

1) income before tax –  $I_{12} = 958.66$  thousand US dollars;

2) actual value of the share of costs associated with the use of natural resources in the total cost of production –  
 $\alpha_{12} = (543.76 + 8.16) / 1,760.14 \approx 0.31$ ;

3) adjusting factor –  $k_9 = 0.31/0.32 = 0.98$ ;

4) accrued income tax amount  $IT_{12} = 958.66 * 0.25 = 236.67$  thousand US dollars;

5) accordingly, the adjusted amount of income tax  $IT'_{12} = 236.67 * 0.98 = 235.33$  thousand US dollars.

As we can see, in case of the technology replacement, there is a reduction in the amount of income tax, and this amount grows slightly in the last two years. Then, it is necessary to analyze the overall results of the impact of tax instruments on the profitability of production.

The above enables to conclude that it is appropriate and effective to use such a mechanism of profit taxation in order to stimulate the processes of environmental innovation. The resulting potential growth is characterized, on the one hand, by an increase in the amount of accumulated net profit, and, on the other, by a decrease in the costs of the natural resource component of such potential. The main criterion for efficiency, however, is to reduce the load on the environment without reducing the quality of meeting the needs of society.

This is precisely the stimulating effect of the proposed tax improvement in the environmental innovation development: change in technologies leads to an increase in the efficiency of using natural resources and a corresponding reduction in the tax burden while the existing proportional scheme fails to do this.

On the other hand, economic systems with relatively advanced technologies (with a higher level of efficiency) are more attractive for capital investment that creates conditions for the reallocation of resources in their favor. On the contrary, industries that use traditional technologies (with low efficiency) will not be able to attract enough resources and will have to suffer losses, which eventually leads to their displacement from the economic space. Accordingly, the ecological and economic macro system will increase its potential.

The use of such mechanism fully corresponds to both the methodology of evolutionary economics and the laws of sustainable economic development, and may sufficiently claim to be universal. The proposed directions for improving the use of tax instruments enable to solve this problem by indirectly influencing the market-oriented processes related to the development of the economy on an environmental innovation basis.

Therefore, taking into account the peculiarities of the environmental innovation nature of economic development is a precondition for the use of tax instruments in the management of such development, and may be carried out, in particular, to adjust the amount of accrued corporate income tax. The proposed method is based on the principles and criteria of financial stimulation of environmental innovation development and provides a systematic targeted regulation of processes that mediate it.

## 5. Conclusion

A systematic approach to improving the financial mechanism for managing the environmental innovation development requires the formation of such a mechanism based on compliance with the principles of environmental innovation potential development. The main directions of improvement of such a mechanism are defined as follows: stimulation of key factors of environmental innovation development; implementation of credit support for the reallocation of the resource component of environmental innovation potential in favor of new, more environmentally friendly technologies; formation of tax policy on market conditions and taking into account the environmental innovation nature of development; financial support for the dissemination of appropriate technologies.

The environmental innovation development of economy, which solves the objective contradiction between the inherent properties of economic growth and existing environmental constraints, is defined as the process of developing the environmental innovation potential of economy, where the latter is understood as ensuring the maximum possible growth of such potential through the effective use of its natural resource component.

Closely related to the target orientation of financial policy is a programmatic approach to the formation and implementation of such a policy, which implies subordination of financial management activities to a single goal and their systemic effect, when the time and spatial characteristics of the tactical application of certain elements of the financial mechanism are determined to achieve a certain strategic goal.

It is found out that the main direction of improving tax policy for stimulating the environmental innovation development of the economy of Ukraine should be to change the focus of the use of tax instruments from the purely fiscal function of filling the budget to the implementation of an incentive function. The authors propose to implement such change by taking into account the peculiarities of the environmental innovation nature of economic development on the basis of adjusting the amount of income tax in relation to the environmental innovation level of production. The differentiation of income tax rates should take place in accordance with the criterion of the share of costs associated with the use of natural resources in the total cost of production.

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