The Innovative Ways of Development in the Oil and Gas Industry of Kazakhstan

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ABSTRACT

The article considers theoretical and methodological approaches to research of sustainable development of the oil and gas industry of Kazakhstan in modern conditions. Oil and gas industry is viewed as one of the priority directions of government economic policy, which is of particular importance in providing sustainable development of the country. It is noted, that increasing of stability of Kazakhstani oil and gas industry development is presented itself one of the most important issue of state economics. Authors identify main problems affecting on innovative development of the oil and gas industry. It was emphasized, taking into account the current trends, stability of oil and gas complex is affected by the number of conjuncture market factors, including price factors, bank interest rates, market conjuncture for this product, or value of its supply and demand in domestic and foreign markets. Main principles and criteria of innovative development of the oil and gas industry were developed. It is proved, that innovative development of the oil and gas industry should be carried out on the basis of the principles. The forecast of innovative development of the oil and gas industry was built on the basis of designed formula. The forecast of revenue from innovations is on the perspective period in the extraction and processing of high-sulfur, light and heavy oil for 2022-2026 that presented as table and forecast diagram. The innovative development of the oil and gas industry should be carried out on the basis of the researched principles. As a result of conducted research priorities of innovative development of the oil and gas industry were identified.

Keywords: Oil and Gas Industry, Innovative Development, Innovation Policy, Innovative Activity, New Technologies
JEL Classifications: O13, Q32, Q55, Q58

1. INTRODUCTION

Industrial and development aimed at the development of clusters, the implementation of "breakthrough" projects of international importance and the country's integration into the world economy is a necessary basis for creating a competitive economy that occupies a specific "niche" in the world economy and is able to quickly adapt to new economic conditions. The Government of the Republic of Kazakhstan marked ways to increase the competitiveness of industry and the implementation of cluster initiatives. Public administration of innovative development of the country's subsoil use is an important problem for countries rich in mineral deposits and specializing in the extraction and processing of natural resources. Industrial and innovative development, aimed at the development and implementation of innovative projects and the integration of the country into the world economy, is a necessary basis for creating a competitive economy in the world economy system and able to adapt rapidly to new economic conditions.

The problem of innovative development of subsoil use is considered as rational use of subsoil resources, aimed at increasing the processing degree of extracted raw materials, the use of processed products based on waste-free production while minimizing harmful emissions into the environment.

2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

Theoretical and methodological approaches to the study of the innovation activity factor, including in subsoil use, have been considered by scientists from different countries (Mensh, 1979; Clare et al., 1981; Titenberg, 1984; Kantorovich, 1986; Kleinknecht, 1987; Santo, 1990; Glazyev et al., 1992; Glazyev, 1993; Zavlin et al., 2006; Rudzka, 2008; Polterovich, 2009; Glor, 2017) and Kazakhstani scientists (Igilik and Sikhimbayeva, 2014; Aimagambetov et al., 2016; Sikhimbayev and Shugaipova, 2017; Sikhimbayeva, 2019).

Kondratiev (1925) considered innovation the most important reason for large cycles of market conditions in his "long waves" theory. Kondratiev pointed out the connection of long waves with the technical development of production, studying the dynamics of innovations in the context of the phases of a large cycle. Kondratiev's ideas had a strong influence on the Austrian economist Schumpeter (1939), who was the founder of innovation. In his work "Economic Cycles" and other works, Schumpeter explored the basic concepts of the innovation processes theory, considering innovations as changes in technology and management, as new combinations of resource use.

The German scientist Mensch (1979), tried to link the rate of economic growth and cyclical nature with the emergence of basic innovations. In his opinion, in a situation where basic innovations exhaust their potential, a situation of "stalemate in technology" arises which determines the stagnation in economic development.

The dependence of the economy and economic growth of technological and scientific development, the use of new technological advances, the implementation of innovations took place in different periods by scientists (Kuteynikov, 1990; Glisin, 1994; Bezdomny et al., 1998; Kovalev, 1999; Astapov, 2001; Yakovets, 2002; Borisov et al., 2003; Prigozhin, 2003; Fathutdinov, 2006; Naryshkin, 2007; Sukharev, 2008; Pavlov, 2009; Tolegen et al., 2018; Khadys et al., 2018).

A special place in the theory development of public administration of subsoil use are the works of Hotelling (1931), who researched and developed the regulation theory of the natural resources exploitation in order to prevent their rapid depletion, He also made forecasts for the growth of the extractive sector of the country's economy based on the ratio of the extractive and manufacturing sectors of the economy. The sources calculation of economic growth was proposed by Solow, 1957, who proposed to use the production function with a constant return on the scale of production and its qualitative state, depending on various factors.

Greenwood and Yorukoglu, 1974, used this idea to construct a model in which major technological discoveries depend on the efficiency of companies' production. There is empirical evidence that agrees with these conclusions.

An interesting idea was expressed in this regard by Aghion and Howitt, 1992. He suggested introducing a limit on the level of technology at any given time into the technology borrowing model. The growth rate falls when technology is borrowed and poor countries approach the production capacity limit set by the technology level of the leading country. Thus, it becomes possible to obtain conditional convergence within this model. A number of models, as shown, indicate the possibility of dependence of the growth rate on the size of the economy.

3. METHODOLOGY AND EXPECTED RESULTS OF THE RESEARCH

The models presented by us reflect attempts to substantiate innovative factors affecting economic development in the oil and gas industry. It is assumed that firms incur fixed costs for the production of a new product, but then receive a permanent monopoly on this product. As before, it is considered that a constant part of the issue is spent on investments. Investments are spent on the creation and introduction of new products.

The production function is

$$N_t = B \left[\int_0^{m_i} \left(y_t^i \right)^{\alpha} di \right] M^{1-\alpha}, \ 0<\alpha<1 \tag{1}$$

Where y_t^i - the cost of the i - intermediate product at time t;

mt – количество затрачиваемых промежуточных продуктов для производства выпуска в момент времени t;

mt is the number of spent intermediate products for the production of the release at time t;

B - is a technology level.

The production function describes an economy with constant returns to scale in labor and intermediate products. Labor resources and, accordingly, real wages are unchanged over time. Therefore, the profit maximization problem is solved as follows:

$$B \left[\int_0^{m_i} \left(y_t^i \right)^{\alpha} di \right] M^{1-\alpha} - \int_0^{m_i} s_t^i y_t^i di - qM \to \max_{y_t^i, M}, \tag{2}$$

where s_t^i is a real (measured in units of output) price of intermediate product i;

q - the real wage rate.

The necessary conditions are:

$$\alpha B \left(y_t^i \right)^{-(1-\alpha)} M^{1-\alpha} = s_t^i, \text{ for every I} \tag{3}$$

$$(1-\alpha) B \left[\int_0^{m_i} \left(y_t^i \right)^{\alpha} di \right] M^{1-\alpha} = q \tag{4}$$

Condition (3) describes the demand for the i product. Suppose that the production of the i product is rewarded by a monopoly on its output, and the costs associated with the production of a unit of this product are λ.

Then the task of maximizing the profit of corporation will be as follows:

$$\max_{s_t^i, y_t^i} \left(s_t^i y_t^i - \lambda y_t^i \right)$$

The solution to this problem is to find

$$\max_{y_t^i} \left(\alpha B \left(y_t^i \right)^{1(1-\alpha)} M^{1-\alpha} y_t^i - \lambda y_t^i \right)$$

and the substitution of the obtained optimal value y_t^i in (2).

The solution of the corporation's problem, therefore, is recognizable in nature and consists in setting a surcharge on marginal costs in the amount of:

$$s_t^i = s = \frac{\lambda}{\alpha} \tag{5}$$

Since the costs for all manufacturers are the same, then prices will also be equal. Then to determine the proposal of each product in equilibrium, we substitute (5) into (3).

$$\alpha B \left(y_t^i \right)^{-(1-\alpha)} M^{1-\alpha} = \frac{\lambda}{\alpha}, \text{ from which } y_t^i = y = \left(\frac{\alpha^2 B}{\lambda} \right)^{\frac{1}{1-\alpha}} B \tag{6}$$

Thus, the offer of each product is the same.

Substituting (6) into (1), we obtain a production function of the form:

$$N_t = \overline{B}\delta_t M \text{ , где } \overline{B} = B^{\frac{1}{1-\alpha}} \left(\frac{\alpha^2}{\lambda} \right)^{\frac{\alpha}{1-\alpha}} \tag{7}$$

Suppose that the creation of a new product requires resource costs in the amount of η for its development and development.

Thus, if the income share p is spent on investments to create and produce intermediate products, then

$$J_t = pN \tag{8}$$

$$J_t = (m_{t+1} - m_t)\eta + \lambda y m_t \tag{9}$$

Formula (9) shows that investment reimburses the costs of creating new products (the first term) and the production of already existing ones (the second term).

From (6) it follows that the growth rate in the economy

$$\frac{N_{t+1}}{N_t} = \frac{\overline{B}m_{t+1}M}{\overline{B}m_t M} = \frac{m_{t=1}}{m_t}$$

It coincide with the growth rate of the amount of intermediate products.

From the formula (8) and (9)

$$pN_t = (m_{t+1} - m_t)\eta + \delta y m_t \text{ откуда}$$

$$p\overline{B}m_t M = \eta m_{t+1} - (\eta - \lambda y)m_t \tag{10}$$

We express out from (10) $\dfrac{m_{t+1}}{m_t} = \dfrac{p\overline{B}M + \eta - \lambda y}{\eta}$

From (10) it follows that

$$\lambda y = \left(\frac{\alpha^2 B}{\lambda} \right)^{\frac{1}{1-\alpha}} \text{ taking into account (7),}$$

By this means:

$$\frac{N_{t+1}}{N_t} = \frac{m_{t+1}}{m_t} = 1 + \frac{\overline{B}M}{\eta} \left(p - \alpha^2 \right)$$

From where the rate of economic growth is

$$\frac{\overline{B}M}{\eta} \left(p - \alpha^2 \right) \tag{11}$$

In the case of s> α2, steady economic growth is observed. The growth rate is the higher, the higher the savings rate.

In the presented model, the growth rate is the higher, the lower the level of costs η, which are necessary for the implementation of research and development for the introduction of a new product, as well as the lower production costs of already existing λ by the formula (7). This model directly reflects the technical progress consisting in the development of new products and the improvement of the manufacture of existing products, with the economic growth rates associated with the costs of its implementation.

In the model, it is observed that growth rates depend on the size of the labor force M, as well as on the size of the economy.

These findings did not find empirical evidence; an analysis of cross-country data did not reveal a link between output growth rates and population size, but the presented model is most suitable for describing developed economies that make significant investments. From formula (11), it follows that the model does not imply either absolute or conditional convergence, since

stable endogenous growth arises in it due to the fact that in the production process of new goods limited production factors are not used, therefore the stock of products can increase without limit. In other words, the model does not incorporate mechanisms that cause a decrease in the rate of expansion of the stock of products as it increases.

Suppose that new products are introduced using skilled labor, the stock of which is constant. In order in this case, steady economic growth, however, was observed, it is assumed that the costs of developing a new product fall with an increase in the existing stock of goods (mt). In such a formulation, the possibility of conditional convergence already appears (as the stock of products grows, its rates decrease due to the limitedness of skilled labor, but remain positive due to the fall in costs of introducing a new product).

In models that imply a limited life cycle of innovations, the manufacturer compares the costs of developing a new product with the benefits of its exclusive use (monopoly power is temporary).

We will, as before, assume that investments constitute a constant part of the issue. With the introduction of a new product, the old one ceases to be produced, therefore the level of variety of goods remains unchanged.

Production function has the form:

$$N_t = B\left[\int_0^1 \delta_{ti}^{1-\alpha}\left(y_t^i\right)^\alpha di\right] M^{1-\alpha} \qquad (12)$$

Where B - level of technology;

$\delta_{ti}^{1-\alpha}$ - quality level of the i - th product at time t;

y_t^i - costs of the I-th intermediate product at time t;

M1-α - labor resources of the company.

The quantity of the i-th product is constant, but resources are required to improve the quality of existing products.

Demand for the i - th product is determined in the same way as the previous model:

$$s_t^i = \alpha B \delta_{ti}^{1-\alpha}\left(y_t^i\right)^{-(1-\alpha)} M^{1-\alpha} \qquad (13)$$

The production costs of the intermediate product are constant and equal to λ, then the monopoly price will also be equal to:

$$s_t^i = s = \frac{\lambda}{\alpha}$$

If we assume that the quality of all goods tends to the level δt (δti = δt), then the production function takes the form:

$$N_t = \overline{B}\delta_t M , \text{ где } \overline{B} = B^{\frac{1}{1-\alpha}}\left(\frac{\alpha^2}{\lambda}\right)^{\frac{\alpha}{1-\alpha}} \qquad (14)$$

Let the quality of new goods depend on already reached level of quality, the resources necessary for an invention and production of these goods (Jtr) and also on the costs connected with research and development (η).

The following type of this dependence is supposed:

$$\delta_{t+1} = \delta_t + \frac{J_{tr}}{\eta} \qquad (15)$$

Equality (15) shows that in an economy with a high level of quality already achieved, it is easier to improve the quality of a product, i.e. the existence of externals is assumed.

Similar to the previous model, we have the form:

Jt=pNt (16)

where p is the share of income that is spent on investments for the creation and production of intermediate products.

Jt=Jtr+λx. (17)

Thus, the economic growth rate is:

$$\frac{N_{t+1}}{N_t} = \frac{\delta_{t+1}}{\delta_t} = 1 + \frac{\overline{B}M}{\eta}\left(p - \alpha^2\right) \qquad (18)$$

From the formula (18) it follows that the rates of economic growth are equal to the growth rates of the quality of goods and coincide with the growth rates of output in the model of the growing variety of goods. They, as well as in the previous paragraph, depend on the size of the economy, given by the size of the labor force. However, in this model, this dependence emphasizes the influence of size on the growth of quality.

It is known that when using the idea of the influence of the scale of the economy, a model of quality steps is used to explain the dynamics of remuneration for qualifications to study the effect of technological progress on changes in the reward of production factors.

In this model, workers are divided into two groups:
• Skilled workers
• Unskilled workers.

Investment in research and development is directed to the production of a product that is used by both groups. Investment costs (η) are fixed. This means that increasing the size of one of the groups may lead to increased research and development aimed at develowping intermediate products that complement this type of labor. The described modification is used to explain why the wages of skilled workers did not fall, despite a significant increase in the share of

skilled labor compared to unskilled. On the basis of the model, it is concluded that the increase in the number of skilled workers led to the creation of goods that complement their work activities, then despite the increase in the supply of this type of labor, its payment rates did not fall, as the demand for it also increased.

The considered models of technological progress are suitable for developed countries. For most countries, the problem lies not in deciding whether or not to spend resources on innovations, but on whether to adopt technologies developed by others. Consider the model of borrowing technology.

Let the production function have the same form as in the model of an expanding set of products according to the formula (1):

$$N_t = B \left[\int_0^{m_i} \left(y_t^i \right)^\alpha di \right] M^{1-\alpha} \quad 0 < \alpha < 1$$

Suppose that all intermediate products are imported and, for simplicity, at the same price s.

Then the optimization problem is reduced to the following formula:

$$B \left[\int_0^{m_i} \left(y_t^i \right)^\alpha di \right] M^{1-\alpha} - \int_0^{m_i} s_t^i y_t^i di - qM \to \max_{y_t^i, M} , \qquad (19)$$

If we substitute this solution in formula (1), then the production function will take the form:

$$N_t = \overline{B} m_t M s^{\frac{\alpha}{1-\alpha}} \text{, где. } \overline{B} = B^{\frac{1}{1-\alpha}} \alpha^{\frac{\alpha}{1-\alpha}}$$

Let's assume, that the number of goods already entered is i ∈ (0, ∞).

Suppose that in order to introduce a new product into the production process, it is necessary to train workers in its use. The costs of training each employee are η, then:

Jt=(mt+1–mt)ηM

It follows that:

$$m_{t+1} = m_t + \frac{J_t}{\eta M} \qquad (20)$$

Where J_t is the investment associated with borrowing new technologies.

If the constant part of the output p is saved, then $J_t = pN_t$ taking into account formula (19), the growth rate of the output will be:

$$N_t = B \left[\int_0^m \left(y_t^i \right)^a di \right] M^{1-a} \qquad (21)$$

Thus, in this model, the borrowing technology cost is proportional to the number of employees, the size of the economy no longer affects the economic growth. Costs, which are an exogenous factor for the analyzed economy, have an impact on the growth rate. All other things being equal, their increase reduces the rate of economic growth. Since the costs of the necessary imported materials and equipment reflect the terms of trade, it follows that the strengthening of the national currency leads to an increase in the output growth rate.

Figure 1 shows the dynamics of innovative activity of oil and gas companies in Kazakhstan.

The most innovative activity is shown by the Tengiz field, the average indicators – the Uzen, the Kumkol, and the low indicators are shown by the deposits Kalamkas, Northern Buzachi, Karazhanbas. The volume of innovative products of the Kazakhstan's largest oil companies for the period 2016-2020 (Figure 2) shows the dynamics of the share of innovative products and new methods of production. The Kazakhstan oil and gas companies has increased the use of new technologies. The innovative methods can allow them to increase production volumes.

Figure 2 shows that innovation processing is still low for some oil and gas companies of the Kazakhstan.

Figure 3 and Table 1 demonstrate the forecast of growth of costs for research and development of innovative projects for 2022-2026, this is due to the insufficient use of new technologies by Kazakh oil and gas corporations.

To forecast and evaluate the prospects of innovative activity in subsoil use, the following factors that affect them to a greater extent are proposed:
- Total production of mineral resources in monetary terms
- The production volume from innovative activities in subsoil use
- The share of special taxation of subsoil use in the total production costs volume
- The amount of state benefits and preferences for innovative products
- Total production costs of mineral resources
- Total production costs for research and innovation
- Costs of borrowing and purchasing new technologies and equipment
- Staff salary costs, including social expenses
- Expenses for the salary of qualified personnel and professional development of employees.

From the listed factors, the indicators that affect the innovative activities development in the subsoil use of the country are identified, the impact of which is shown in the function below.

The function of income from innovations in subsoil use can be expressed by the following formula:

Y = F (x1, x2, x3, x4, x5, x6, x7),

Figure 1: The innovative activity of the Kazakhstan oil and gas companies for the 2016-2020
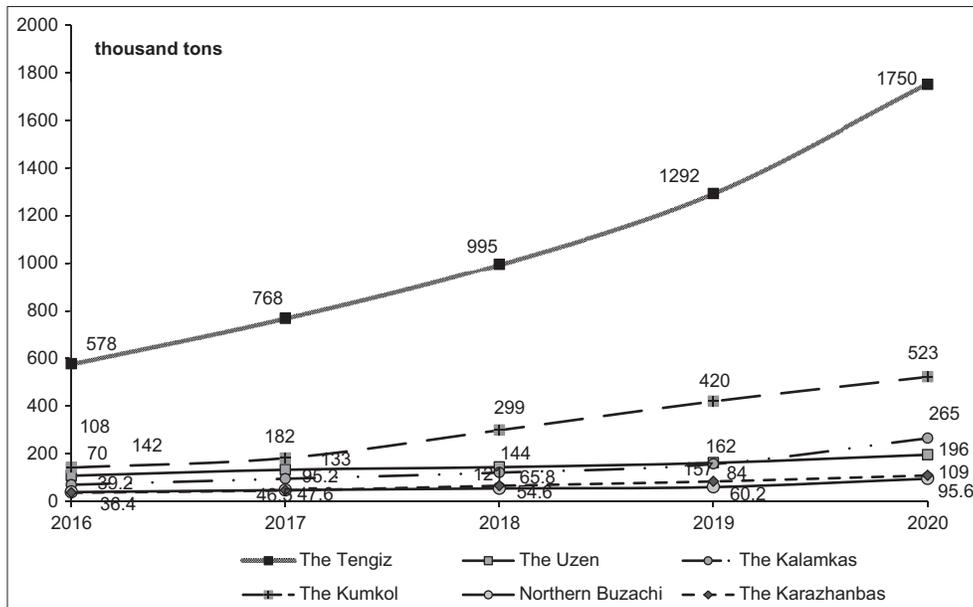
Source: Authors' calculation, based on the Oil and Gas of Kazakhstan, 2016-2020

Figure 2: The volume of innovative products of the Kazakh oil and gas companies for the 2016-2020
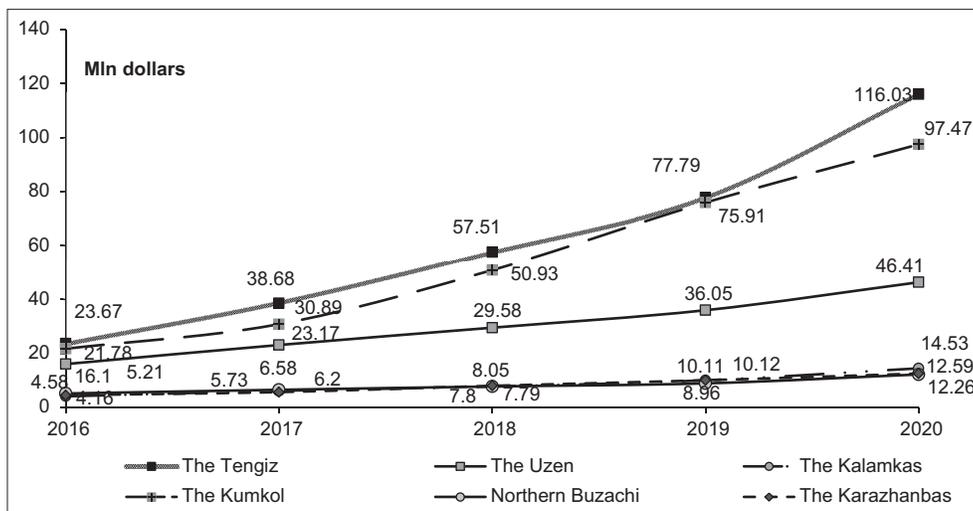
Source: Authors' calculation, based on the Oil and Gas of Kazakhstan, 2016-2020

Table 1: Forecast of income from innovation in the extraction and processing of high sulfur, light and heavy oil for 2022-2026

| Base of crude oil	The share of income from oil extraction, million dollars					The share of income from innovation, million dollars				
	2022	2023	2024	2025	2026	2022	2023	2024	2025	2026
High sulfur	947.1	1287.2	1636.2	1897.6	2320.5	5.64	7.15	8.44	10.12	13.82
Light	1059.1	1273.3	1500.2	1619.2	1892.1	9.03	10.01	11.82	14.57	17.14
Heavy	208.5	238.6	260.1	289.1	322.8	1.93	2.83	4.55	5.73	7.06
Total	2214.7	2799.1	3396.5	3805.9	4535.4	16.6	19.99	24.81	30.42	38.02

Source: Authors' calculation, based on the Oil and Gas of Kazakhstan, 2016-2020

Where
x_1 - increase index in the total production of mineral resources;
x_2 - growth of production index from innovative activities in subsoil use;

x_3 - share of special taxation of subsoil use in total production costs;
x_4 - increase index in total production costs for research and innovation;

Figure 3: The internal costs of Kazakhstan's oil and gas companies innovative projects for the 2016-2020
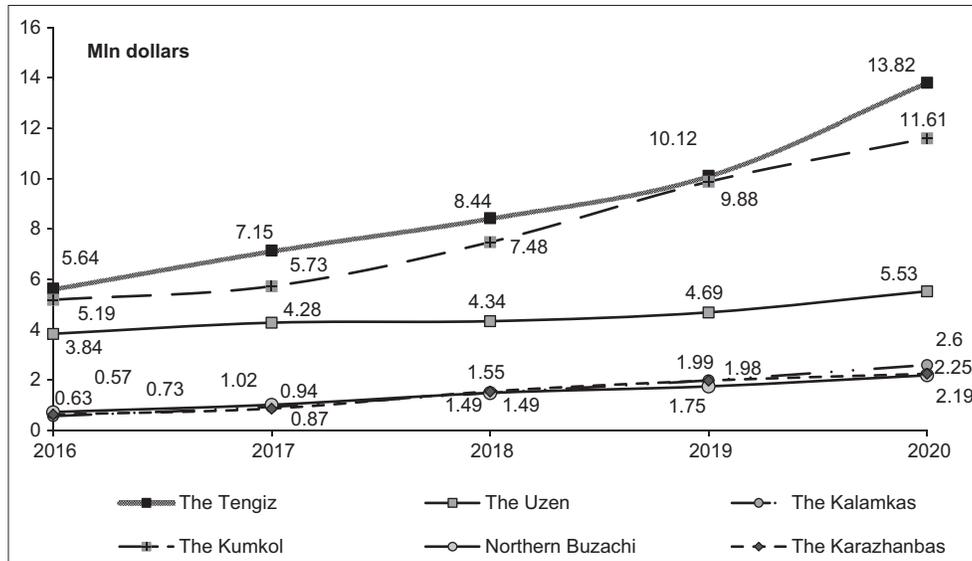
Source: Authors' calculation, based on the Oil and Gas of Kazakhstan, 2016-2020

Figure 4: Forecast of revenue from innovations in the extraction and processing of high-sulfur, light and heavy oil for 2022-2026
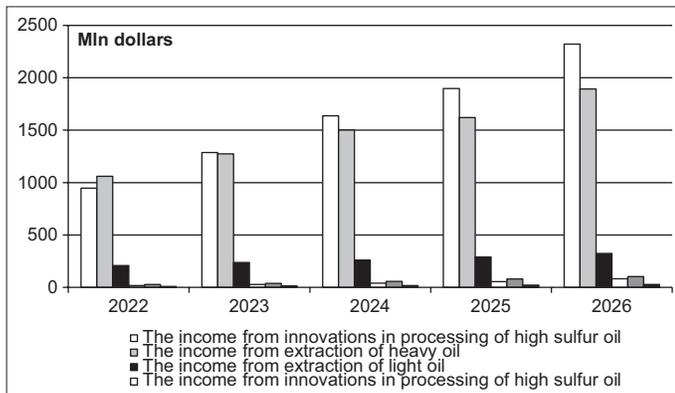
Source: Authors

x_5 - cost growth index for borrowing and purchasing new technologies and equipment;
x_6 - increase index in staff salary costs, including social expenses;
x_7 - increase index in the cost of wages of qualified personnel and professional development of employees.

As a result of the correlation and regression analysis, we get:

$$Y = 0{,}75x_1 \cdot 1{,}654x_2 \cdot 1{,}121\ x_3 \cdot 1{,}457\ x_4 \cdot 1{,}562\ x_5 \cdot 1{,}321\ x_6 \cdot 1{,}269x_7.$$

The greatest impact on the innovative activity volume growth in the mining industry is shown by:
- The production volume from innovative activity in the subsoil use
- Total production costs for research and innovation
- Costs of borrowing and purchasing new technologies and equipment
- Salary expenses of qualified personnel and professional development of employees.

Less impact was shown by:
- Total production of mineral resources in monetary terms
- Total production costs of mineral resources
- Total production costs for research and innovation
- Staff salary costs, including social expenses.

Table 1 and Figure 4 show the forecast for the innovation activities growth of income from the extraction and processing of mineral resources for the period 2022-2026.

4. CONCLUSION

The advantage of the described models is that they highlight new growth determinants associated with new decisions of subsoil user companies regarding the innovations use. These are the costs associated with unit production of a mineral resource, the resource costs in the process of research and development creating a processed product, the employee training costs to use a new product in the production process, the imported intermediate products prices.

With regard to Kazakhstan's conditions of subsoil use, innovative activity in mining companies in Kazakhstan is still more of a process rather than a product. That is, there is an improvement in technological processes, purchase of borrowed technology and equipment for extraction, production and processing of mineral resources.

Product innovation is mainly about highly processed products future planning.

Based on the conducted analysis and calculations and the relevance of the current situation in the economy of Kazakhstan, we find that innovations in subsoil use show a positive correlation depending on the new technology borrowing factor.

Thus, the innovative activities development in the subsoil use of the country will develop new high-tech industries; will increase the effectiveness of state scientific and technical policy. The science and production integration will be achieved, free access to national scientific and technical information will be provided, and the technological gap in priority areas will be reduced, including the processing industry development and the new industries creation spheres.

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