Development of a Rental Mechanism for Reducing the Technogenic Risks in the Coal Industry

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Abstract. The article examines reducing the technogenic risks in the coal industry by differentiating the withdrawal of mountain rents from mining enterprises of different types (cuts and mines). It is shown that the general level of the technogenic risks when using the open method of extraction is not inferior to the underground one. Consequently, the increase in the specific gravity of this method in the coal mining structure increases technogenic risks and requires protection from them. The purpose of the article is to develop a technical and economic mechanism capable of removing mining differential rent for coal mines in order to improve the balance of the production structure. The methodology of the study is based on the use of correlation-regression, factor analysis, expert assessments. The value of the differential mining rent arising in the Russian coal industry is determined using an open mining method in comparison with an underground mine method. The ratio of man-made risks and the value of mountain rents are estimated using different mining methods. A mechanism has been developed for the withdrawal of differential rent cuts, supplementing the existing model of the tax on the extraction of minerals. The possibilities of using a collection or a target payment for the use of an open coal mining method are shown to protect against the corresponding technogenic risks, to compensate for the accumulated damage.

1. Introduction

The development of the world's coal industry has led to an increase in the share of the open method of coal mining. To date, it accounts for about 60% of the world's coal production [1]. Advantages of the open method of extraction are lower production costs, higher labor productivity, higher production capacity of the extracting enterprise, and a reduction in the risks of injuries and deaths for production personnel [2, 3]. In the Russian coal industry, the share of the open method of extraction is much higher than world benchmarks. In 2016, it was about 73% [4]. In parallel, the volume of coal mining and exports, the profit of coal companies increased. Consequently, the growth in the share of open production is due to economic reasons and contributes to improving the economic performance of coal companies. Along with this, the risk to the health and life of the personnel is reduced. However, the open method of extraction causes significantly higher technogenic, environmental risks. This is due to the withdrawal of large territories from circulation, the violation of natural landscapes, mass dusting during open works, noise pollution. So far, it has not been proven, but the seismic danger of explosions in open mining is actively being debated.

At present, certain aspects of environmental damage from open mining, arising from increased man-caused risk, have been studied well. In particular, the effect of open mining on the disturbance of soil cover and natural landscapes was studied [5, 6]; the effect of explosive and overburden work on...
the emission of pollutants into the atmosphere [7, 8, 9]; environmental damage from coal dumps [10, 11, 12]. Technogenic risks of coal mines for human health are well known [13, 14]. Existing studies show a higher level of man-made risk of mining open-pit coal compared to underground mining. Consequently, an increase in the share of the open method in the overall structure of coal mining requires protection against man-made risks.

Since open-pit mining has a higher level of economic efficiency, in the absence of special control actions, its share will continue to increase. The choice of the method of extraction belongs to the competence of the coal company and depends on the geological and geological factors of occurrence of the deposit. However, a high technogenic risk requires compensation and should not be considered as a net cost to the local community. The mechanism to reduce the technogenic risks of open mining requires the use of economic levers that affect the behavior of mining enterprises. They must also provide compensation for the accumulated environmental damage to coal mining by open pit.

In the known literature and world practice there are no technical and economic mechanisms for reducing technogenic risks, depending on the use of different methods of mining. In particular, taxation of coal mining takes into account its market value, consumer value, supply direction (domestic market or export), place of extraction [15, 16]. Therefore, the purpose of this article is to develop a technical and economic mechanism to reduce the technogenic risks of the coal industry. This mechanism should be rental in nature, since the choice of the method of extraction is due to differential mining rent. The difference in differential mining rent, depending on the method of extraction, affects the neutrality of taxation. The tax on the extraction of minerals (coal), which does not take into account the production method, is not neutral, therefore, leads to rejection of the decisions taken from Pareto-efficient decisions [17].

It is known that differential mining rent is withdrawn by the state [18, 19], since it depends not on the efficiency of the mining enterprise, but on natural factors. This gives grounds to put forward the hypothesis that taxation of coal enterprises taking into account the production method reduces technogenic risks on the basis of achieving a balanced production structure. Elimination of negative incentives to increase production with significant negative externalities causes a reduction in man-made risks. Next, consider the impact of mining on the activities of coal companies and the ability to ensure a neutral for this factor of taxation.

2. Results and Discussion

To assess the influence of the mining method on differential mining rent in the coal industry, the authors used data on the volumes of production and financial results of the largest Russian coal companies (according to public records). The initial material for the study is shown in Table 1.

Table 1. Empirical data for assessing the impact of mining on the financial results of coal companies.

| Name of the coal company | Share of the open method of extraction, fractions of the unit | Transport costs, million rubles | Profit without transportation costs (gross), million rubles | Operating profit, million rubles | Net profit, million rubles |
|--------------------------|---------------------------------------------------------------|-------------------------------|------------------------------------------------------------|-------------------------------|--------------------------|
| SUEK                     | 0.70                                                          | 99405.5                       | 145522.1                                                  | 38207.1                       | 20310.1                  |
| Kuzbassrarezugol         | 0.93                                                          | 2738.7                        | 19227.4                                                  | 9907.6                        | 2689.6                   |
| SDS-Ugol'                | 0.75                                                          | 860.0                         | 625.7                                                     | 160.2                         | -2426.8                  |
| Mechel                   | 0.66                                                          | 6184.0                        | 34245.0                                                   | 23932.0                       | 21865.3                  |
| PAO Raspaskaya           | 0.33                                                          | 507.7                         | 6428.3                                                    | 5920.6                        | 12957.5                  |
| PJSC Belon               | 0.01                                                          | 262.8                         | 182.8                                                     | 101.0                         | -111.0                   |
| JSC Russian Coal        | 1.00                                                          | 6974.5                        | 8368.6                                                    | 765.6                         | 867.0                    |
| PJSC Kuzbasskaya         |                                                               |                               |                                                           |                               |                         |
| Toplivnaya Company       | 1.00                                                          | 12374.8                       | 14282.6                                                   | 1163.1                        | 600.4                    |
| Sibuglemet-M             | 0.33                                                          | 167.6                         | 159.3                                                     | -8305.0                       | -4936.0                  |
| JSC Vorkutaugol          | 0.15                                                          | 4288.0                        | 16417.0                                                   | 9011.5                        | 4591                     |
Based on the data presented in Table 1, the authors evaluated the influence of the share of the open production method on the financial results of the coal company using standard methods of regression analysis. The results of the calculations show that the ratio of mining methods used in the coal company significantly affects the financial result. The specific gravity of the open method in the structure of total coal production has a significant correlation with the profitability of sales. The correlation coefficient is 0.523. As a rule, the higher the share of the open method in the production structure, the higher the profitability of sales, other things being equal. This is understandable, since the cost price of extraction by the open method is much lower, and the price of coal does not depend on the method of extraction.

Graphically, the dependence of the profitability of sales of coal companies on the specific gravity of the open production method is shown in Figure 1.

![Graph showing the dependence of profitability of sales on the specific gravity of the open production method.]

**Figure 1.** Dependence of profitability of sales on the largest coal companies in Russia (vertical axis) from the specific gravity of the open production method (horizontal axis).

The linear equation of regression, which characterizes the influence of the share of coal mining by the open method on the profitability of sales of the coal company, has the following form (1):

\[ Y = 0.145x - 0.0157, \]  

where \( x \) is the specific weight of coal mining by the open method in the coal company; \( Y \) – profitability of sales.

The coefficient of determination of the regression equation (1) is 0.2524. Therefore, this regression equation accounts for about 25% of changes in the profitability of sales of coal companies. Hence, the conclusion is that the financial results of the coal company are approximately 25% dependent on the proportion of open-pit mining. This proves the existence of differential rent depending on the method of extraction (more precisely, from the mining and geological conditions that determine the choice of...
an open mining method). At hypothetical transition of the coal company from completely closed to completely opened way of extraction and preservation of other conditions profitability of sales will increase in addition by 0.15 or 15%. At the same time, the system of rent taxation of nature users operating in Russia (the tax on the extraction of minerals in the form of coal) does not take into account the different economic efficiency of different methods of coal mining.

The existing mechanism of the mineral extraction tax in the form of coal does not practically remove the differential rent due to favorable mining and geological conditions. Therefore, in order to form a rental mechanism for reducing man-caused risks, depending on the method of extraction, this tax must be differentiated.

Tax differentiation is a complication and variation of elements of the tax mechanism in relation to various taxpayers, objects, territories, conditions. Differential or flexible taxation is more equitable, has better fiscal and regulatory capabilities. A characteristic method of differentiation is the introduction of special coefficients, different rates, taking into account the differences in the activity of taxpayers, the tasks of state economic policy.

The differentiation of taxation of mining operations in world practice is carried out according to the production or financial-economic approach [20-23]. Within the framework of the first one, mining and geological characteristics of mining enterprises, the quality of extracted raw materials, and the stage of the life cycle of the deposit are taken into account.

Within the framework of the economic approach, they seek to withdraw excess profits from subsoil users that exceed a certain norm. It is possible to combine the elements of the two approaches provided that the overall acceptable level of load is observed. The financial and economic approach is more in line with the economic nature of rent and is more correct in content, since it theoretically allows taking into account all the factors affecting the level of the mountain rent. The production approach is easier to administer, does not require deep analytical work on a large amount of information.

It should be borne in mind that there are no perfect mechanisms for removing natural rent either in theory or in practice. We can only talk about increasing the degree of flexibility, fairness, neutrality of taxation, withdrawing an increasing share of rent, promptly adjusting the tax mechanism in accordance with changes in the industry, technologies, and the coal market. In addition, the correctness of the quantitative assessment of the factors that determine the differences in the level of the mountain rent, directly depends on the accumulated statistical information base.

This makes it possible to recommend that an additional extraction factor of 1.15 of the base rate for the extraction of differential rent for more favorable mining and geological conditions be established for the mining tax on coal produced by the open method. Thus, for taxation of open-pit mining, it is advisable to increase the existing rate by 15%. The following additional financial resources will be received (Table 2).

| Table 2. Estimation of the consequences of the introduction of the production method factor for the differentiation of the mining tax in the form of coal (base year for comparison is 2016). |
|-----------------------------------------------|
| Russian Federation | Kemerovo Region |
|---------------------|----------------|
| Total coal production, million tons | 386 | 227 |
| including open-pit mining, million tons | 281 | 145 |
| Actually received tax on the extraction of minerals in the form of coal, million rubles | 3870 | 3682 |
| Additional income tax on the extraction of minerals in the form of coal when using the production conditions factor in the amount of 1.15 for the cuts, million rubles | 80.4 | 120.6 |
| The increase in the tax on the extraction of minerals in the form of coal in the form of coal, percent | 2.1 | 3.3 |
| The share of additional encumbrance in the balanced financial result of the coal industry, percent | 0.05 | 0.12 |
In assessing the authors, a minimal estimate of the tax rate for mining operations in the form of coal was adopted, assuming that only coals are extracted by the open method. Even with this condition it turns out that the budget of the Kemerovo region can additionally be attracted, at least, 120.6 million rubles. At the same time, in comparison with the balanced financial result of the Russian coal industry and the Kemerovo region, the additional tax burden cannot be considered significant. Differentiation of the tax on extraction of minerals in the form of coal by the method of extraction will contribute to the formation of a more equitable model of taxation and equalization of the competition conditions in the industry.

However, the main objective of the proposed rental mechanism is to equalize production conditions, reduce man-made risks, including through compensation for previously accumulated environmental damage. In particular, the coal industry is characterized by considerable accumulated environmental damage in the form of land disturbances. In the Kemerovo region, where there is a high spatial concentration of open mining operations, a significant amount of land is disrupted. The rent mechanism for reducing man-made risks has financial potential, which can be used for reclamation works. Estimation of the extent of land reclamation using the proposed mechanism is presented in Table 3. The cost of reclamation of 1 hectare of disturbed lands is accepted at the level of 500 thousand rubles.

**Table 3.** Evaluation of the potential of the rental mechanism to reduce the technogenic risks of the coal industry (for example, the reclamation of disturbed lands in the Kemerovo region).

| Year   | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 (rough estimate) | 2018 (forecast) |
|--------|------|------|------|------|------|------------------------|-----------------|
| The area of disturbed land at the end of the year, thousand hectares | 66.9 | 70.1 | 73.3 | 76.3 | 76.9 | 77.0                   | 76.0            |
| Reclaimed land, thousand hectares | 0.9 | 1.2 | 0.7 | 0.1 | 0.4 | 0.6                   |                 |
| Ratio of reclaimed lands to disturbed lands, percent | 33.8 | 62.3 | 24.5 | 16.7 | 16.7 | 40.0                   |                 |

Consequently, the formation of a rental mechanism to reduce man-made risks in the coal industry can compensate for previously accumulated environmental damage and reduce the negative impact on the environment.

3. Conclusion

In the development of the mining industry, there is a contradiction between economic efficiency and the technogenic risk of an open method of coal mining. The absence of a neutral mechanism for the withdrawal of rents arising from the use of an open mining method causes negative externalities. Ecological damage is higher than using an underground mining method; it is assigned to the local community.

Consequently, a rental mechanism for reducing and compensating technogenic risks of the coal industry is needed. It is based on the withdrawal of differential rent, due to mining and geological conditions, which make it possible to develop deposits in a more economical open way. Simultaneously, this method is associated with higher technogenic risks.

The study proves the existence of differential rent by the method of coal mining and quantifies its value. It is shown that the mining method determines 25% of the variance in the profitability of coal company sales, using the open coal mining method, the profitability of sales increases by an average of 15%. These regularities make it possible to propose a rental mechanism for reducing man-made risks. The mechanism assumes the withdrawal of differential rent at the expense of a coefficient of 1.15 to the existing tax rate for the extraction of minerals in the form of coal. This will eliminate unreasonable incentives to increase the proportion of open mining, to compensate for the accumulated environmental damage.
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