

On classification and assessment of regional economic and social effects of the implementation of projects for mining of solid minerals deposits

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Abstract: The main regional economic, ecological and social effects resulting from the implementation of design solutions in the field of mining of solid mineral deposits are systematized in general. Two cases are distinguished, for which the new enterprise production is mainly consumed within the region and outside it, resp. Typical impact on transport branch and social sphere is studied for both cases. The paper mainly concentrates on the case of Russian Federation, since differences in legal system (in particular, the fiscal system), culture of everyday life, territorial distribution and mobility of population, as it is shown in scientific literature, lead to different form of interrelation between these factors in involved countries and regions. Their influence on incomes and expenses of local budgets depending on the economic conjuncture and the state of the manpower market is considered. Direct and indirect effects are taken in to account, the latter resulting from additional amount of services due to increase of total wages in the local mining industry. A formula for budget increment because of the new production including the indirect effects is derived. Particular attention is paid to the problem of selecting the level of completeness of the stock extraction in the project. Economic and ecological consequences of the latter are considered in detail. The problem rests to reveal significance of impact of expected mineral industry activities on different sectors of the local economy, for which probably the statistical method by Toda and Yamamoto may be applied.

Keywords: solid minerals, mining projects, budget, tax revenue, economic effects, social effects.

1. INTRODUCTION

The problem of regional economic and social effects caused by development and expansion of mining production as well as by its reduction is important for all mining countries. Many factors have universal significance and are to some extent characteristic for the development processes of other branches of heavy industry, but their combination has significant national and even regional specifics. In this regard, the vast majority of studies are focused on the problems of a specific country and a particular region, and generalizing works that could formulate patterns for the world as a whole are absent.

E.g., in the paper [7], despite its title, only the case of Canadian province British Columbia is studied and its fiscal system is addressed; nevertheless, some way of quantitative assessment of dependency between local mining industry activities and regional economic development for more general use is proposed.

The lack of universality is caused by significant differences in legal system, culture of everyday life, territorial distribution and mobility of population of involved countries and regions. Despite that, conclusions of researches may be useful for analysis of situations lying far beyond the scope of the papers.

The impact of rise or decline of local mining industry to most economical sectors of regional economy of different countries (Canada, Poland, Turkey, Sweden) is investigated in [1, 3, 4, 7]. Most effects are seen via changes of employment in main sectors of regional economy. Economic and social effects of migration caused by mining industry development in peripheral areas “characterized by remoteness, a scattered population, and limited access to infrastructure” [4] are studied in [4, 9, 11]. It must be emphasized that such conditions are typical for Russian mining industry as well to most other large northern countries.

The paper [10] as well as many other ones concentrates on development of knowledge-intensive service activities directly serving Australian mining sector. Most principal features of impact of mining industry activities on public health that are typical not only to Australia are studied in [8].

Taking into account results of the above mentioned (and other) researches, we restrict our attention to the case of Russian mining industry.

Russian mining industry, on the one hand, is a very important part of the economy, and on the other, is extremely unevenly distributed. Enterprises that do not belong themselves to the leading enterprises of the national mining industry, nevertheless, can make a very significant contribution to the regional economy and social sphere.

When selecting and approving mining projects for solid mineral deposits (SMD), the interests of the state-proprietor of subsoil (subsoil owner) and subsoil user organization are taken into account [14, 18]. The significance of a particular mining enterprise being designed at the federal and regional levels is not the same, thus it is not possible to speak of a single state interest in connection with the mining project. In some cases, the national interest dominates, because of which local interests may not be sufficiently taken into account when selecting a project, for local enterprises it is vice versa.

When considering the project variant, one should try to take into account all projected revenues to budgets, as well as budget expenditures (for social support measures, environmental protection). The indicators that determine the commercial efficiency of a mining project are basically the same as for other industries (adjusted for the more pronounced random nature of their estimates), but the national and regional economic effects are much more diverse and much less accountable. Thus, in [14, p. 235], in addition to tax revenues, payments for the use of subsoil and customs duties received directly from the subsoil user, “additional tax revenue (or losses) from third parties, due to the impact of the project on their financial situation”. In this article, an attempt is made to reveal more details of the situation in question and to take into consideration, in addition to revenues, also budget expenditures, as well as indirect economic effects.

2. GENERAL CHARACTERISTICS OF REGIONAL ECONOMIC AND SOCIAL EFFECTS OF PROJECTS OF INDUSTRIAL ENTERPRISES CREATION

Emergence of the new production in itself creates several principal effects for the region in which it is located. If its products are consumed mainly within the region (which is typical, for example, for the production of steam coal that provides local power stations and population needs as well as for construction materials quarries), then its consumers pay to the new manufacturer instead of the former suppliers (presumably from other regions). In addition to increasing the profitability of production for consumers, which justifies shift to new suppliers, the effect of the latter is that the payment for the products they supply remains in the region. As a result, this leads to an increase in the profits of regional producers and the total wages of workers. For some transport enterprises, on the contrary, owners loose profits and employees their salary; however these losses are obviously much less than the increase for consumers and new manufacturers.

If the produced products are mainly intended for consumers outside the region, then the income of the created enterprise is added to the income of the regional economy. In this case, additional income can also be received by transport companies in the region, if they are engaged in the delivery of these products.

At the same time, a number of industries, including mining enterprises, can have a negative impact on the environment, mainly through pollution. Penalties that companies pay for identified cases of pollution cannot always compensate this negative effect. The consequences of pollution, first of all, are the increase in the morbidity, which requires additional investments in the health care system. At the same time, only the maintenance of the health of the employees of polluting enterprises can be taken on the responsibility of the company and carried out at the expense of its revenues.

3. THE MAIN ASPECTS OF THE IMPLEMENTATION OF MINING PROJECTS TAKING INTO ACCOUNT THE ECONOMIC AND SOCIAL ENVIRONMENT

Before considering the issue of comparing alternatives for a specific mining company's project taking into account indirect effects, we note the following fundamental aspects of the impact of such enterprises activities on the region.

3.1. Market for Sales of the New Enterprise Production and its Relations with Project Indicators

Production at the new enterprise can either compensate for the outgoing capacities of other mining enterprises, or create the opportunity to replace imported raw materials (but thereby reduce the burden on transport infrastructure and employment in transport), or serve as a means for creating new industries in the region (supply of raw materials or energy) or in other regions, or, at last, for exports increase. Thus, for projects in question, it is necessary to take into account their effect on the functioning or development of industry and transport, and in the case of exports, on payment of the export duty.

Industrial production (or power generation) on a regional scale can depend heavily on the extraction of a particular raw material at a particular location due to high transport expenses, or, on the contrary, it may be economically acceptable to replace this production with imported raw materials or substitute raw materials or energy transfer from other regions. In the latter case, the possible volume of sales in the local market (and beyond it, indeed) is closely related to the offer price.

Project alternatives differ not only in terms of the estimated level of prime cost, and consequently, in the level of prices of sales of products, but also in terms of the achieved quality values of products. It would be more accurate in many cases to suppose the relationship between cost and the main (or cumulative) quality indicator. The latter refers to cases where the use of raw materials is permissible in a fairly wide range of quality, but the efficiency of the production usage depends on it. This is typical, in particular, for power stations generating energy by coal combustion. Thus, project alternatives differ in economic indicators not only for the mining enterprise itself, but also for consumers of its products, including local consumers.

With regard to the objectives of maintaining existing industries or energy companies, one should take into account the sensitivity of their profits and other elements of the tax base to the costs of raw materials and to assess the additional effect as the difference between budget payments for various project options, provided that the raw material in the corresponding project is purchased at the projected enterprise, and the missing volume — on the external market beyond the region. In the case when the supply of raw materials from other sources is unprofitable, one

must take into account the sensitivity of the profit of the consumer of raw materials to the volume of production. Similarly, the contribution of a mining enterprise to the economy of the region (and even of the country) needs to be assessed when its creation is a prerequisite for the creation of new industries.

3.2. Significance of Transport and Energy Transfer Infrastructure

For most types of mineral products, significant physical volumes are typical, and as a result, its transportation creates a considerable, sometimes the main load of transport system of the region. Handling this load may impose restrictions on the economic activities of the region.

The existing road network and transport fleet provides a certain amount of transport work, and its increase requires investments, transport infrastructure development demanding sufficient time for its expansion. If the enterprise being created is sufficiently profitable, it can afford, in case of a shortage of transport resources, to pay a higher price for transport services. But in this way transport needs for other, less profitable activities will not be fully met. In this case, the costs of the regional transport system development for satisfaction of requirements for the transportation of the products of the company being established or expanded should be attributed to its account.

On the contrary, in the case of a significant reserve of the transport infrastructure capacity, investments in its development are not required, but transport fleet increase should be provided at the expense of the created enterprise except for the situation of prevalence of transport services by interregional organizations.

The most important processes of mining, namely excavation, conveyor transportation and processes of primary processing (crushing, sorting) are energy-intensive and carry a high load on the energy system of the region. The latter is especially important for energy-deficient regions and can have a negative effect on other economic activities.

3.3. Ecological Aspects

The environmental effects of mining of SMD are very diverse and may not always be expressed in monetary terms. Among other things, the territory of a mining allotment is withdrawn from other types of activities, including agriculture and forestry. Obtaining a land tax does not necessarily compensate for the loss from the shortfall in payments to the budget from other commercial activities that have not taken place on this territory. On the other hand, a significant part of mining enterprises is located where there are no conditions for efficient agriculture.

Unfavorable environmental effects can have varying degrees of significance. For example, in the Pavlodar region of Kazakhstan, where the largest Ekibastuz coal deposit is located, there is also a fairly developed grain farming, but not in the vicinity of the field itself. Therefore, the pollution of soils by coal and rock dust, which dissipates from the faces and dumps, does not have a significant negative economic effect. Quite the reverse situation is in the zone of the Kursk magnetic anomaly, abundant with fertile black soil.

Unfavorable ecological environment can affect not only other types of economic activity, but also the health status of the population. Consequently, nature protection measures have different costs depending on the state of the local economy, especially agriculture and forestry, and the resettlement of residents.

According to the authors of [20], the existing penalties do not fully cover the costs of compensating for the negative impact of industrial activities on the state of the environment and suggest a formula for correcting the GRP (gross regional product) taking into account the following:

- Costs for wastewater treatment in accordance with the cost of cleaning;

- The cost of greenhouse gas emissions (CO₂ equivalent) in accordance with prices in the carbon market;
- Costs for removal and disposal of production and consumption wastes in accordance with the fee for negative impacts.

But the above mentioned factors do not cover the entire pollution cost. Perhaps the most significant impact of them is on the health of the population. It should be noted that in some cases, employees of an enterprise exposed to harmful working conditions and the population not directly related to production, but experiencing its negative impact, are in an unequal position. The mining company is to a certain extent interested in maintaining the health and physical fitness of its employees and, at the expense of its revenues, can pay for recreational activities and other health measures, and, if necessary, also treatment. At the same time, it will hardly be engaged in charity with respect to the entire population of the territory. A typical example of this is the main subdivision of PJSC MMC Norilsk Nickel - its Polar Division with a center in Norilsk. By common belief, the environmental situation in Norilsk is very unfavorable. Meanwhile, in respect of the employees, there is a whole system of measures. Employees are provided with various social guarantees, benefits and compensations aimed at health improvement, treatment and recreation on Russian and foreign resorts [12].

As for the rest of the population, additional health care costs, along with the mandatory medical insurance Fund, must be paid by the local budget. Therefore, regional interests should be taken into account in the form of a requirement to implement a sufficiently high level of environment protection measures in the project. However, this level may be the result of a compromise between the requirements of maintaining a favorable ecological environment and the economic interests of the regional budget and the population in obtaining additional revenues as a result of the projected enterprise.

4. SOCIAL IMPORTANCE OF A MINING ENTERPRISE

An enterprise or a branch of industry that is a consumer of a particular type of raw material may have high social importance being the main (city-forming) enterprise in some territory. In this case, the raw material supply of such production becomes an important social and economic task. The region should seek the adoption of a project for a mining enterprise that maximizes the volume of break-even production in a supported enterprise and offers a compromise option for the selling price of this raw material.

Regional labor market, including occupations related to mining operations, may have a different ratio between supply and demand, as established at the level of wages. Different versions of the project, the differences in volume and profitability differ, and what wages they can offer to employees. But it must be estimated from the actual level in the region — the idea put forward by F. W. Taylor who was one of the founders of the management theory [16].

5. THE EFFECT OF COMPLETENESS OF DEPOSIT EXTRACTION

As it was noted in [2], one of the key parameters distinguishing project variants proposed for selection and approval is the completeness of extraction of balance reserves, in other words, the percentage of their losses during extraction. In the same works, a fact is noted that seems paradoxical for authors, that in typical cases, the most profitable project variant for both the subsoil user and owner is the variant with the highest loss level. The authors of [2] link this fact to insufficient consideration of budget revenues not only directly from the project (i.e., paid by the subsoil user), but also “in connection with the project” (paid by consumers of mineral raw

materials). We accept this position, but we do not absolutize the importance of the completeness of the extraction of mineral reserves in the light of the side effects discussed in this paper.

The main factors associated with the completeness of extraction of reserves:

1. The volume of production and sales.
2. The cost of extraction and primary processing.
3. The effect on cost efficiency among consumers of raw materials.
4. The need for workers and their level of payment.

The increase in the completeness of the extraction of reserves either requires an increase in the degree of selectivity of their development, which leads to a complication of technology, poor performance of mining machinery (or the use of less productive and thus less economical machines), or leads to an increase in the dilution of mined minerals.

An example of the first case is the project of using layer-by-layer cutters instead of single-bucket excavators when working out complex-structural coal deposits in Eastern Siberia. Clogging of coal with rock and loss of coal in this case, indeed, decrease, but the cost of production also increases.

It should be noted that the increase in the completeness of the extraction of reserves at the expense of their dilution has an ambiguous effect on the total profit across the entire production chain, and thus on budget payments. When burning high-ash coal, the output of electricity per unit of calorific value of fuel falls, so to ensure the power generation process it is necessary to add fuel oil to the furnace, which increases the cost of production, which generally depends on the technologies of fuel combustion [6, 15, 19]. The cost of ash removal influences the growth of the cost price. Diluted ore not only increases the cost of its enrichment, but also cause losses in the process of enrichment, so the concentrate amount may be even smaller than when enriching a smaller amount of unsoiled ore. Therefore, the loss of a certain portion of the reserves, accompanied by an increase in the amount of the final product, is beneficial both for producers and for the budget. In the case of a certain reduction in the volume of the final product, but a significant reduction in the cost of production along the entire production chain, the total effect depends on the correlation between economic indicators.

6. DIRECT AND INDIRECT RELATIONSHIP BETWEEN PROJECT INDICATORS AND BUDGET REVENUES AND EXPENDITURES

Alternatives associated, in particular, with the different completeness of the extraction of balance reserves (and, consequently, with the different quantity and quality of the produced raw materials) can be viewed from several viewpoints, and the role of the factors listed below depends on the type of mineral, the place of extraction, the state of the budget and the labor market at both the federal and the local scale.

The mining enterprise, depending on the project variant, employs a different number of workers in extraction, primary processing (sorting, enrichment) and transportation to its consumers (including transportation within the region). In addition to the main payments to the budget from the subsoil user (the tax on the extraction of minerals and the tax on profit), their employees also pay income tax. The total wage non-linearly depends on the number of hired employees. With an excess of labor supply, an increase in the number of employees, together with a decrease in the enterprise's income per employee, entails a decrease in wages, and in the case of a deficit, on the contrary, the employment of new workers becomes possible only with an increase in wages, even if the income per employee decreases. The change in the unemployment rate changes the costs of benefits, retraining, housing subsidies and other measures of social support.

The social consequences of the adoption of a particular design decision take place, first of all, at the regional level. It was noted above that the variants differ in the different number (and composition) of the labor force involved in the development of the deposit and the accompanying and related business processes. The increase in the aggregate wage of these workers makes it possible to develop the services sector to “absorb” a part of this increase, which in turn increases payments to the budget from the services sector. Such an indirect effect can be identified for any production, not just mining.

The state statistics provide publicly available data on the structure of the nation-wide gross product. Obviously, the same data can be obtained for the regions. Among the highlighted classification headings, along with mining, processing industries, construction, as well as various categories of services.

In turn, the main ways of using the gross domestic product (GDP) are assessed quantitatively. Data from the source “On production and use of (GDP) for 2016” [13] that are of the greatest interest to us, are shown in Table 6.1.

Table 6.1. Data on the structure of the GNP of the Russian Federation in 2016

Components of GDP in basic prices	Share (year), %	Share for quarters, %			
		I	II	III	IV
Agriculture, hunting and forestry	4.5	2.3	3.4	7.2	4.5
Fishery, fish farming	0.3	0.4	0.2	0.3	0.2
Mining	9.4	8.6	10.1	9.7	9.1
Manufacturing industries	13.7	12.5	14.1	13.6	14.4
Generation and distribution of electricity, gas and water	3.1	3.9	2.7	2.5	3.4
Construction	6.2	4.5	5.5	6.4	7.8
Wholesale and retail trade; repair of motor vehicles, motorcycles, household goods and personal items	15.9	16.9	15.9	15.3	16.0
Hotels and restaurants	0.8	0.8	0.9	0.9	0.8
Transport and communication	7.8	8.4	8.1	7.8	7.2
Health and social services	3.8	3.9	3.8	3.7	3.7
Other communal, social and personal services	1.7	1.8	1.8	1.6	1.7

Other important data from [13] are:

as to the structure of GDP use: final consumption expenditure as a whole it is 76.6% and 55.8% for consumption of households;

as to the structure of GDP by source of income: compensation of employees (including labor remuneration and mixed incomes not observed by direct statistical methods) is 46.7%.

As it can be seen, the share of final consumption varies significantly even within a year. Analysis of the correlation between such indicators allows to predict the change in the volumes of various types of services, accompanying changes in the volume of industrial activity and total wages in this area.

According to the Budget Code of RF [15], taxes received by the regional budget directly from the activities of a mining enterprise are:

- 1) the tax on the extraction of minerals (for general-distributed solid minerals and natural diamonds — 100% of the amount of tax, for other solid minerals — 60%);
- 2) the tax on profit of organizations — 18% of its value;
- 3) the tax on income of individuals (company employees) at a standard of 85%;
- 4) the tax on property of organizations — 100%;
- 5) transport tax.

An increase in the total wages of workers in both the created and consuming and servicing organizations will be spent in large part within the region. To do this, the total volume of services (in particular, trade, which, obviously, in the amount of GRP, as well as in the amount of GNP is a very significant share). In turn, some of these revenues turn into wages of organizations and individual private entrepreneurs working in the service sector.

Let the increment of the total wages in the non-consumer sector be amounted to ΔW_1 . On the basis of statistical processing of the data in the form of linear regression, we assume that the elasticity of local consumption with respect to wage $K_{12} \cdot \Delta W_1$.

In turn, we will assume that for workers in the services sector (the consumer sector) the share of their wages spent on services is K_{22} and that a unit of income in the consumer sector yields the amount of profit K_{P2} and the amount of wages K_{W2} .

To define the unknown increase in the volume of services in monetary terms, caused by ΔW_1 , we employ the balance of revenues in the services sector be expressed by the ratio

$$K_{W2}(K_{12}\Delta W_1 + K_{22}\Delta W_2) = \Delta W_2 \quad (6.1)$$

Thus, we obtain for the increment of the total wage the formula

$$\Delta W_2 = K_{W2}K_{12}\Delta W_1 / (1 - K_{W2}K_{22}) \quad (6.2)$$

In addition, the increment in profit in the services sector will be

$$\Delta P_2 = K_{P2}(\Delta W_1 + \Delta W_2). \quad (6.3)$$

This means that the cumulative increase in the regional budget revenues from the profit tax of the listed organizations of the non-consumer sector and all consumer sector organizations, as well as the personal income tax of workers of these organizations and individual private entrepreneurs will be

$$0.18(\Delta P_1 + \Delta P_2) + 0.13 \cdot 0.15(\Delta W_1 + \Delta W_2). \quad (6.4)$$

This is the main budget effect of the new production, which will be different for different project variants. Here, the effect of increased consumption by the owners of the organizations in question is not taken into account, which is more difficult to assess, in particular, because some of them do not live permanently in the region. But in any case, it can only increase the revenues of the regional budget.

Other effects, such as a change in the cost of social support due to a possible reduction in the level of unemployment or to eliminate the effects of environmental pollution, are less predictable and require special study of the current factors.

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7. THE TIME FACTOR IN THE ASSESSMENT OF PROJECT OPTIONS

All that was said above did not take into account the time factor. As a general rule, in order to determine the cumulative effect for a subsoil user, the company's estimated profit is summed by years, taking into account discounting; the same is done with respect to budget revenue. The net discounted income expresses (approximately, due to fluctuations in the economic conjuncture and technological changes) the real economic interest of the entrepreneur and the investor. For a state or region that, in general, spends the budget not for the economic benefit and is not a creditor even in the case of a budget surplus (although potentially it can be a creditor and even an investor), the goal is rather the guaranteed receipt of budget revenue as permanently (or, better, in ever-increasing volumes). On the other hand, not being a creditor, the region is more often a debtor who is interested, if possible, to pay off loans more quickly. This justifies the use of the traditional formula of net discounted income for the project's budget contribution, but with a lower discount rate than for the subsoil user, because the state or a region usually takes a loan at a lower interest rate than the business.

8. CONCLUSION

The proposed approach yields the preliminary estimation of main regional economic effects, direct or indirect, that may result from a certain project for the development of a SMD. It does not, however, reveal significance of impact of expected mineral industry activities on different sectors of the local economy. With the use of more sophisticated statistical methods, such as the method by Toda and Yamamoto [17], it looks likely that the most significant effects may be found in advance on the base of the study of analogs. In that case it would be possible to explore these effects in more detail for more perfect decision making.

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