Economic Variables of the Mineral Project like the Factors Affecting Cash Flow

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Ekonomické premenné z projekcie minerálov ako faktory ovplyvňujúce peňažný tok
The task of analysing the investment and concrete project is to ensure reliable information connected with designing, mining method, production costs, recovery, consulting means (e.g. character of used bank systems, geo-statistic and geographical information systems, etc.) and many other variable factors.
In fact it is necessary to use quantitative values for project variables, based on technical analysis. Only in instances when variables are quantified, a study of the economic efficiency of the mining business can result in conclusions and a quality investment decision can be made.

Key words: *investment, mining project, cash-flow, net present value, time value of the money, pay back period*

Introduction

When assessing the economic efficiency of investments implemented by means of a project, with the effort being to comprehend its internal consequences, it is necessary to proceed step by step, and gradually implement all variables affecting its result into the project assessment. In order to reach such an outcome, it is suitable to split the project analysis into four basic levels:
- study of the basic project,
- taxation and depreciation effects,
- loans and their effects on a project,
- study of the whole project (taxes and loan).

When studying the basic project, the most important thing is to identify whether the economic development of the project implementation guarantees positive results and an economic return on the spent investments. In fact, the expression of rate is not so important as the actual environment in which the project will be located is considered in the mentioned levels.

Economic Variables of the Project

The economic variables of the project are those parameters which affect its economic outcome. When enhancing already existing projects it is necessary to take into consideration the gained experience which, however, without detailed analysis cannot be applied to the new situation. The situation with new projects is more complicated because all variables need to be estimated together with the corresponding degree of risk. Even the best methodology for estimating the economic viability of a mining business can be inaccurate when it deals with untrue input information. Estimations are done by means of models, which are based on the quantity of so far implemented projects with the addition of specific conditions, characterizing the place of extraction, mineral or the method of its further handling.

The fundamental economic variables, which are essential from the point of view of the evaluator's approach for making his/her imagination of the project more definite, concerning specified methodology, include (for each variant of calculated reserves):
- income,
- capital costs,
- production costs.

Income Estimation

The calculation of annual income consists basically of a multiple of the quantity of excavated and sold final product, e.g. a concentrate during one year and the unit price of the sales product. Calculation is quite

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simple but the validity itself is suppressed by the incorrectness of input data. Calculations in details are stated in the chapter *„Sales of concentrates"*.

Income

In general, income in the majority of cases for raw materials (Fe, bauxite, phosphates,...) as well as more valuable products (Ag, Au,...), are calculated based on the relation:

$$R = T_{conc} . SP \qquad [Sk.year^{-1}], \qquad (1)$$

where: R - income [$Sk.year^{-1}$],
T_{conc} - concentrate quantity [$t.year^{-1}$],
SP - sales price of a ton of a concentrate [$Sk.t^{-1}$].

Sales price of a concentrate

Amount of produced concentrate from excavated ore can be calculated from the following relation:

$$T_{conc} = \frac{T_{ore} . g_{ore} . \rho}{g_{conc}} , \qquad (2)$$

where: T_{conc} - concentrate quantity [$t.year^{-1}$],
T_{ore} - annual production of ore [$t.year^{-1}$],
g_{ore} - ore concentration [$g.yeat^{-1}$],
ρ - mill efficiency [%],
g_{conc} - concentrate concentration [$g.t^{-1}$].

The sales price of concentrate depends on the type of product and its quality. For many products the quality also includes the presence of elements which improve or impair its quality. E.g. Ag or Au are the elements which improve the price mainly in concentrates of basic metals, and on the other hand As, Fe, Bi are polluters in the concentrates of basic metals, S in coal and SiO_2 in bauxite.

General relations for the calculation of sales price of basic metal concentrates are:

$$SP = \alpha . Q . g_{conc} - F - T \qquad (3)$$

or

$$SP = Q(g_{conc} - \beta) - F - T , \qquad (4)$$

where: SP - sales price for a ton of concentrate [$Sk.t^{-1}$],
α - paid portion of pure metal in concentrate [%],
Q - price of metal [$Sk.g^{-1}$],
β - reduction of pure metal portion in concentrate [$g.t^{-1}$],
g_{conc} - concentration of concentrate [$g.t^{-1}$],
F - processing costs [$Sk.t^{-1}$],
T - transport costs [$Sk.t^{-1}$].

Notes:
1. or β and processing costs F also encompass in themselves a surplus for a manufacturer.
2. Part of income belonging to a mining company.

When mentioning the sale price it was in fact the price of concentrate, which is produced by a processing facility. Only in the case that this facility is a part of the whole project can we say that the income from selling the concentrate is the income for the whole project. In case, when the processing facility is a separated and project independent company, the income of a mining company is only a part of the income gained from concentrate sales. Then a mine shares income in accordance with the following relations:

$$MP = \frac{SP}{Q . g_{conc}} , \qquad (5)$$

$$MP = \frac{SP}{Q.g_{conc}} = \alpha - \frac{1}{g_{conc}}.\left[\frac{B}{Q} + E.\left(1 - \frac{Q_{ref}}{Q}\right) + \frac{T}{Q}\right], \qquad (6)$$

where: MP - income of mines [Sk],
Q_{ref} - reference price of metal [$Sk.t^{-1}$],
B - processing costs, if the price of metal equals to Q_{ref} [$Sk.t^{-1}$],
E - factor which adapts processing costs to the current price of metal [%].

When studying the economic efficiency of a mining business it is necessary to work with the mentioned inputs in such a way as to reach the expected result. These inputs can be estimated on the basis of mentioned procedures, on the basis of experience with a similar project, but also it is possible to proceed in an opposite direction. Whole analysis performed by means of a table processor gives a possibility to proceed from results to variables, and from stated economic outputs to calculated adequate inputs. An the end, when specifying possible inputs, it is necessary to assess, whether the given situation is real and if so, how large a risk it is connected with, or if not, by what measure can input changes be accepted to get closer to reality for the inputs.

Estimation of Costs

The goal and advantage of a *feasibility* study is the possibility of as detailed exploration as possible of all the factors having an effect on the project. Firstly, it is necessary to gather all the available data and process them by standard numeric methods defined for them.

Basic data processing steps are:

- defining cost items,
- collecting data based on defined items,
- classifying information,
- analysing relations between information,
- taking advantage of relations between information.

Capital Costs

In heavy, and particularly the mining industry, capital costs or capital investments mean the total volume of funds, which brings the whole project into activity.

Total capital costs consist of two basic parts. Fixed investments and working capital. Fixed investments represent the financial volume, which is needed to prepare and construct the whole set of the project facilities, in a way to have the project ready for the start:

- acquisition of land,
- terrain work,
- preparation of extraction (displacement of a hanging wall,...),
- environmental studies and legislation proceedings,
- erection of an extraction facility (buildings, equipment,...),
- construction of a processing unit (buildings, equipment,...),
- supporting infrastructure (roads, railway, and connections to power supplies,...),
- project studies and engineering costs,
- other consequences.

The operating capital can be understood as the financial cash that ensures the running of a project starting from the period of its commencing until the first financial flow resulting from the implementation of the project's product sale. The estimation is that it represents approximately between 10 to 20 % of the fixed investments, or between 1 to 4 months of the estimated production costs. This method is more common in the area of raw material dressing and processing. In the mining industry it is more suitable to define the amount of operating capital as follows:

$$operational\ capital = A\ x\ B\ x\ \frac{Y\ months}{12\ months}, \qquad (7)$$

where: A - are production costs per one ton of produced raw material [Sk],
B - is annual production,

„Y months“ – is the time that passes from the date of commencing the project until the time when funds are gained as a result of running the project. This time is called a „pipeline length“ (pipeline) which means the time until the product is transferred to a consumer,

12 months“ – the time period that the variable „B“ is related to.

It should be pointed out that operating capital increases the volume of capital costs. Operating capital is included in the project from its beginning, and „flows“ through the project during its existence. At present a trend exists to monitor the volume of this capital periodically during the entire project duration in order to calculate impacts of inflation.

The method of similarity

This estimation method consists of the calculation of a coefficient related to a very similar project. It is based on imitating an already existing project and using its experience. In fact it is a simple imitation of projects with known capital costs.

The method of unit costs

This method consists of the multiplication of the volume of future annual production of a new mine by individual unit capital costs (per production unit, i.e. a ton) for individual items of capital costs. Data for this method can be obtained from technical literature, state and financial institutions or specialized advisory companies. In some ways this method is close to the method of similarity, however the difference is that it can also consider different situations than those in the implemented project. While, when using the method of similarity, it is necessary to also consider the similar size of the mining facility, with the method of unit costs it is possible to move within a certain range limited by corrections to unit costs. In the case of exceeding these limits inaccuracies can occur, as unit costs are constant only within this range.

The following example can prove the calculation of capital costs for the construction of a copper producing mine. Data on unit capital costs obtained from the literature give the value of 10,800 USD for a ton of copper annual production produced by quarry extraction. If a new quarry for the copper extraction is to have an annual production of 90000t, then the estimated capital costs for this quarry will be as follows:

$$\textit{10,800 USD x 90,000 t = 972 mil. USD.} \qquad (8)$$

The method of turnover rate

The method of turnover rate also uses historical data. A rate of turnover is the ratio of produced value to a ton and total investments. For example, if a rate of turnover of a copper extracting surface mine is estimated between 0.30 and 0.35 and if the price of one ton of product is 2,000 USD, then the estimated amount of investment is calculated as follows:

Investment related to 1 t: 2,000 USD/ 0.30 = 6.667 USD for a ton of annual production,

Total investments: 6.667 USD x 100 000 tons of annual production = 666.7 mil. USD.

The method of setting up rate

The method of setting up rate is based upon the fact that a project can be expressed in the following form:

$$\textit{Capital costs} = k\,(\textit{annual production})^x, \qquad (9)$$

where: x - exponential factor,
k - constant.

The method estimates the capital costs of a new project on the basis of already existing projects taking into consideration their rate of annual production. The exponential factor takes into consideration the fact that the rate of capital costs increase is directly proportional to the rate of annual production increase.

$$\frac{(\text{capital costs})A}{(\text{capital costs})B} = \left(\frac{(\text{annual production})A}{(\text{annual production})B}\right)^X, \qquad (10)$$

In this case the most critical quantity for the estimation of costs is the value of x.

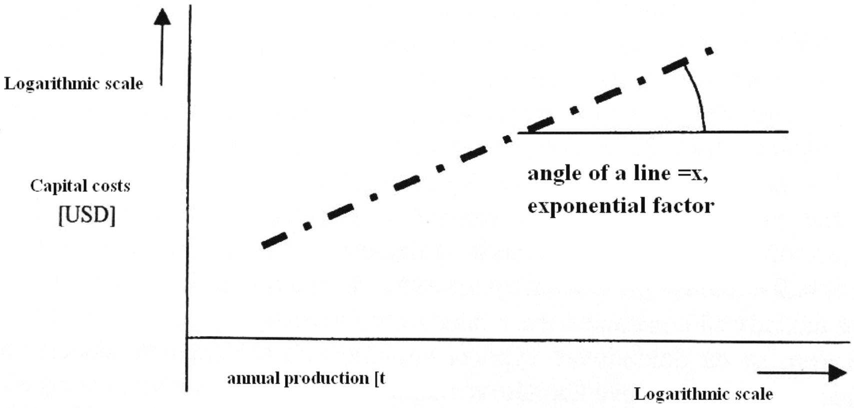

Fig. 1. Graphical expression of an exponential factor.

The determination of the value of x is based upon the curve expressing the annual production - capital costs. Its calculation consists of the collection of data on capital costs and annual production of various projects from technical literature and other already mentioned resources. The exponential factor is defined on the basis of a graphical presentation of the input data and dependencies is expressed by the straight line angle that represents the set of dependencies expressed on a logarithmic scale. Fig.1 shows the graphical expression of an exponential factor.

When making analysis it is very often possible to come to a contradiction with the above stated method, i.e. the dependency between quantities is not expressed linearly. The result then is a curve, as illustrated in Fig. 2. A dependency displayed this way can be interpreted from the viewpoint of expressing the exponential factor within the range from 0.4 to 1.1. Therefore it is necessary to identify the proper range of the annual production rate properly.

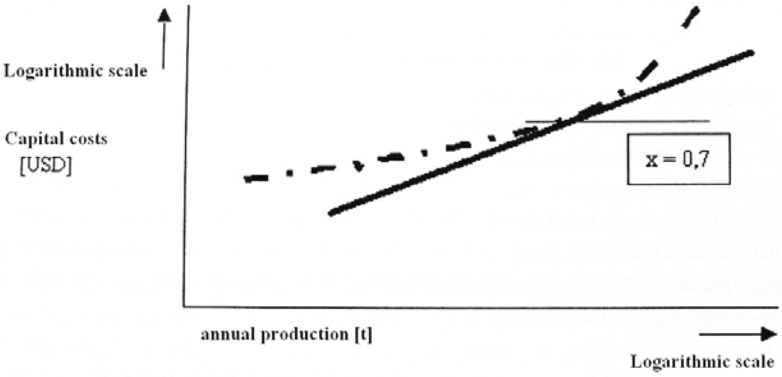

Fig. 2. Non-linear dependence between variables.

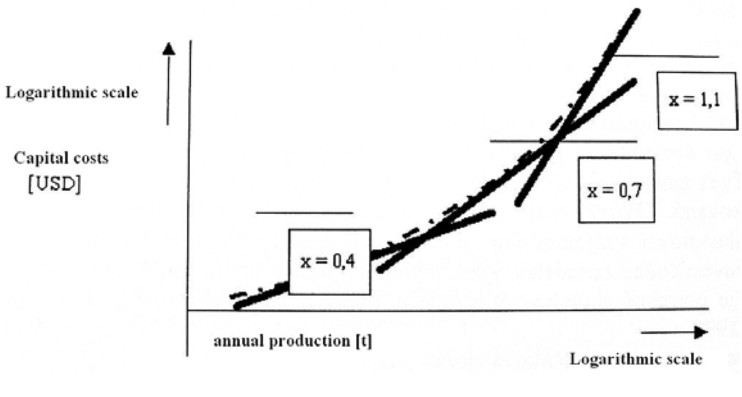

Fig. 3. Production rate effect on capital costs.

This knowledge helps to define another fact, mainly the identification of a limit achieved when in the case of exceeding a certain rate of production in excess of the exponential factor above the value of x =1 occurs. This limit is known as the economic size of a plant. When this value is exceeded a non-economical growth of the amount of capital investments occurs as a result of an increase in the amount of capital investments due to the increase in the amount of the necessary annual production of a plant. As Fig. 3 proves, for better orientation, it is suitable to divide the spectre of annual production into smaller parts to identify more precisely the value of the exponential factor in them.

General Structure of Capital Costs (Spheres of Investment)

1. access roads,
2. terrain work,
3. mining:
   - o preparation of production (investment mining works)
   - o mining plant
   - o accommodation capacities
   - o temporary storage facility during construction
   - o mine facilities
   - o engineering and construction costs
   - o operating capital

4 processing:
   - o crushing,
   - o milling,
   - o waste site, mud pit,
   - o processing plant facility,
   - o accommodation capacities,
   - o engineering and construction costs,
   - o operating capital.

5. management and service activities.

Conclusion

The economic evaluation of projects respects recent trends in adjudicating the economic effectiveness of projects developed in the most advanced economic systems and at the same time adapts it to particular project conditions. This approach respects not only economic but also mining, geological and environmental factors and their effects on the project results, thus giving a view of the complex interrelations of all project variables. The financial analysis is also suitable due to the reason that financial experts, based on the study, have the possibility to understand whether the project is profitable and what its main risks and advantages are.

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