

## ECONOMIC ANALYSIS OF MINING PROJECTS

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**Abstract:** The investment projects in mining industry doesn't significantly differ from any other capital investment project. There are some specific characteristics that must be considered because they affect the final conclusion. This paper are focused on: depletion allowance, different appraisal methods of investments projects, decision tree of investment in mining industry and the most used method to measure the uncertainty and risk - the expert assigning of probability distributions.

### 1. INTRODUCTION

The economic analysis is necessary for making decisions concerning extraction and processing of mineral resources: the engineering design of the development of a deposit, the acquisition or sale of a deposit, a change in the mining and processing methods, a change in the extraction rate and/or extraction level, an assessment of value of assets for taxes purposes; re-evaluation of the investment programme; the evaluation for the purposes of leasing.

With the limited financial resources of the firm, any manager must choose the best investment opportunity from those available. The economic analysis must answer to two important questions: does the investment project satisfy the objectives of the firm? and how does this project compare with other investment opportunities?

A major goal for many firms is maximization of the profit or minimization of the short/run losses. The goal may be expansion of production capacity, an increase in firm's market share, diversification, vertical and horizontal integration. Each of these goals has a role in processes of planning and consequently in the economic evaluation of the investment projects. Rank ordering of investment projects according to priorities of the firm ensures that a specific project is justified to the goals of the firm and provides guidelines for the distribution of limited financial resources. Even there was only one investment opportunity, it must be compared with other generating profit economic activities. Therefore, the concept of the opportunity cost has to be integral part of each economic analysis.

### 2. CHARACTERISTICS OF THE DEVELOPMENT OF EXTRACTIBLE NATURAL RESOURCES

The investment in extractible natural resources projects don't significantly differ from other capital investments. There are some specific characteristics that are considered in the analysis, because they affect the final conclusions. Four specific factors are mentioned: the long period from the geological discovery to the use of the mineral which usually could be 8-12 years, the political and social environment of the extracting regions, the nonrenewable nature of the mineral and energy resources, taxation burden and allowance resulting from the extraction. These factors are reflected in the analysis in terms of long pre/production period, restricted life time of the extraction and specific taxes - royalties - and tax allowances - depletion.

Other factors - the heterogeneous nature of deposits and the restricted quantity of commercial product in any mineral and energy deposit may raise the problem of geological

and technical uncertainty; also and unstable political, economic and social conditions give the risk of takeover, expropriation or the shutdown of extraction.

The main elements in the analysis of mining projects are the accounting of depletion allowance and determining of net cash flows.

## **2.1. DEPLETION ALLOWANCE**

Depletion is the exhaustion or diminution of the mineral and energy resources as a result of their extraction. Depletion allowance represents an amount that is deducted from the net revenue and decreases income before taxes. The depletion is given to the owner of extractible natural resources. Only the royalty owners may claim to depletion deduction.

United States allowed, for the first time in the world's practice, a provision for depletion – it established an allowance so that revenue resulting from a decline in natural resource value should not be taxed as income. The concept of depletion allowance was accepted by the most of the economic developed countries.

There are two methods for calculating depletion allowance: “cost of depletion” and “rate of depletion”. First method compute the depletion allowance as follows: the sum from the cost of acquiring the deposit property and exploration expenditures incurred in discovering this deposit is divided by the estimated remaining reserves, and the result is multiplied by the quantity sold during the year. The second method calculates deduction for depletion as percentage of the net revenue. The depletion must not exceed 50 percent of net income before taxes, computed without the deduction for depletion.

The depletion allowance under method - rate of depletion - is always more than under the method – cost of depletion. The owner may deduct depletion even he has recovered the full cost of the property. The depletion allowances have an important role for development of mineral and energy resources, because they are additional sources of financial funds for further investment in exploration and development of new deposits.

The table 1 presents computing of accounting profit of a mine.

## **2.2. CASH FLOW**

Obtaining or estimating the information needed for an economic appraisal of mining projects is followed by the determining of accounting profit for the life of the projects. Accounting profit further is covered in to net cash-flow - the best indicator of return on investments.

Cash-flow measures the actual flow into or out of the project per given period of time. Net cash-flow is the difference between revenue inflows and outlays for operating costs and capital expenditures. Ordinary investment projects generate negative cash-flows changing into positive flows after production starts. Net cash-flow differs from the accounting profit in three items: depreciation allowance, depletion allowance and capitalized investments. The first two items are added to the accounting profit because they are “inside flows” for the firm - these are permissible deductions from profit for tax purposes and affect the cash-flow indirectly. Capitalized investments are investments with an expected life time exceeding one year. Non productive exploration activity may also be capitalized. Capitalized investments are not permissible deductions for the period in which they occurred, but because they are actual expenditures they must be deducted in computing net cash flow. Computing of the net cash flow is presented in table 2.

Table 1. Accounting profit of the mine

	(1) Gross revenue
Less (1) 0.2	= (2) Royalty payments
(1) – (2)	= (3) Net revenue
	(4) Expensed investment
	(5) Operating costs
(4) + (5)	= (6) Total costs
(3) – (6)	= (7) Gross profit
	(8) Depreciation
(7) – (8)	= (9) Balance 1
(3) 0.1	= (10) Depletion
(9) – (10)	= (11) Profit before taxes
(11) 0.5	= (12) Taxes
	(13) Tax credit
(12) – (13)	= (14) Adjusted taxes liability
(11) – (14)	= (15) Net profit after taxes

### 3. METHODS OF INVESTMENT APPRAISAL

The more common methods of investment appraisal in mining industry are: the accounting rate of return ARR, the payback period PB, the net present value NPV, the internal rate of return IRR and the Hoskold method.

The accounting rate of return ARR was in the past the most popular for mining managers method. It is still applied because of its simplicity and the definite final result. Shortcomings: it doesn't use the conceptions of time value of money and cash flow, the residual value of asset is ignored and there is no basis of real comparison between profits or rates of return, obtained in different time periods.

The payback period PB is the simplest evaluation technique. It is a very appropriate criterion for the profitability of the investment projects. It is also applicable, to some degree, for measuring risk. Long time projects are risky, at least because it is not easy to forecast future cash flows. Investments in relatively short time projects protect the firm against risk. The payback period reflects the liquidity of investment projects. Weaknesses: time value of money is not considered, cash flows beyond the payback period are neglected. The method doesn't give a satisfactory assessment of profitability – shorter term period projects are not always more profitable. It may be used as an indicator for rank ordering for projects with identical lifetime and the same cash flows.

Net present value NPV considers the time value of money, cash flows and the full life of the projects. Rank ordering of alternative investments is meaningful only if the initial investment and the lifetime of the projects are identical. The problems here are determining the cost of capital which is not always constant over the life of project and that stressing the profit maximization, it disregards liquidity of the firm.

The Hoskold method uses two interest rates - a speculative one of investment in sinking funds. Presumption in the method is that the profits obtained will be invested in sinking funds. Sinking funds are not attractive in modern financial management. Using of sinking funds reduces the amounts invested in mining activity and reduces the overall profitability. Speculative rate can't increase to compensate the negative effect of the safe rate over the profit. According to the managerial theory the statement that the higher rate

compensate the higher risky operations correct. Risk probability is measured by other techniques, not by different interest rates.

Table 2. Accounting profit and net cash flow of the mine

	(15) Net profit after taxes
Add	(8) Depreciation
Add	(10) Depletion
(15)+(8)+(10)	= (16) Balance
Less	(17) Capitalized investment
Add	(18) Other cash adjustments
(16)-(17)+(18)	= (19) Net cash flow

The internal rate of return method (IRR) has three main advantages: it shows the real rate of return of capital investment; it gives a meaningful measure of the profitability of projects; it depends to a lower degree on the cost of capital.

The main disadvantage of this method is the implicit assumption that all the cash flows are reinvested in opportunities that yield the same rate of return. This assumption is valid only under certain conditions. Ordinary, the rate of return of investment is highly variable.

In conclusion, NPV gives almost always more precise assessment of rank-ordering than IRR.

More of the financial experts recommend the NPV method, but the statistics data shows that the managers prefer the IRR method.

#### **4. UNCERTAINTY AND RISK**

The economists use the term risk to define uncertain situation that can be described with probability distribution. Uncertainty is a situation for which probability distribution can't be constructed. In recent years this concept was changed. Risk is accepted as a consequence of possible uncertain outcomes. For example, the outcome of investment decision is not certain, so there is a risk of losses. The magnitude of uncertainty in mining projects is larger than in most other industries. On the basis of restricted geology information several important decisions must be made – about the method for development of deposit, the production capacity and the processing plant. Uncertainty can arise in the estimation of reserves, in the assessment of demand and prices or a result of government policy. The combined effect of all these sources of uncertainty has a significant impact over the cash flows and the rate of return. This effect may be large even when the different types of uncertainty have a low probability of occurrence. Therefore, the measurement of the uncertainty and risk is very important for making real assessment of the profitability of investment.

The most used method for measurement the uncertainty and risk is the expert (subjective) assigning the probability distribution to the variations in the value of the variables. The managers of ore mine can decide that the uncertain variables are only two: operating costs and the price of ore. The probability distribution of both variables must be assigned by the experts, who have the best information – e.g. the chief engineer for operating costs and the director of marketing for the variations in the ore price. Standard deviation, computed on the basis of probability distribution is an absolute measure of risk.

The best aspect of this method – the expert assessment – may lead to incorrect results. The people are inclined to compromises in their own favor. The mining engineer will overestimate production efficiency, while the marketing director will favor higher prices. As a consequence, operating costs will be lower and the price and profit will be larger.

## **5. CONCLUSIONS**

Two main conclusions may be made:

1. There is not a common acceptable rate of return of the investment projects in mining industry.

2. There is not a precise method of evaluation of these projects.

If the manager must choose between several alternatives, he computes IRR and probability distribution with expected value and standard deviation for each alternative. But there are some questions that need answers: are the results he has estimated acceptable for all managers and investors and under all circumstances? Does the project that is attractive for one firm is attractive for another? What is the required rate of return? The problem is that definite answers of all these questions can't be given.

In principle, the preferences of the company depend on the profit, productivity, objectives, capital and the skill of the human resource. Under conditions of changing economic environment the preferences may vary – the case when the profitability is connected to high level of uncertainty.

The rate of return is not the only criteria for investment appraisal, although for more of the managers it is a main factor. Preferences of the company depend on the intuition and personal judgement of the manager.

A best method of investment appraisal in mining industry does not exist. Although new techniques of investment appraisal including the conceptions of cash flows and time value of money are more precise than the traditional but they are not perfect. Their efficiency depends to high degree on the objectives of the analysis. A full investment profile can be realized only with additional analysis of uncertainty and risk. In most cases managers use two different appraisal methods. If the results obtained from both methods are similar, the manager's conclusions are reinforced. If the results are contradictable, manager must solve contradiction using other appraisal methods.

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