New approach to the basic evaluation of raw material resources in market economy

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Nový prístup k oceňovaniu ložísk v podmienkach trhovej ekonomiky

V článku sú popísané aspekty ekonomickej analýzy pri oceňovaní zásob nerudných surovín. Tieto sú odrazom banského priemyslu na Slovensku a taktiež ich spotreby na Slovensku. Ďalej sa článok zaoberá adaptáciou a použitím nových progresívnych prístupov k oceňovaniu ložísk nerastov, s príkladom implementácie v oblasti ťažkého priemyslu.

Key words*: raw material evaluation, feasibility study, actualisation, sensitivity study.*

Introduction

The mining industry in the former Czechoslovakia with strong proportion of the mining enterprises, until 1989 - 90, supplied industry area by fossil fuels products like is indicated in table 1 and by mineral products like is indicated in table 2.

Tab.1. Average yearly production of energetic the row materials.

Raw Material	Average yearly production
Black Coal [mil. t]	21-24
Brown Coal and Lignite [mil. t]	107-110
Mineral Oil [mil. t]	0,2-0,3
Natural Gas [mil. m^3]	0,5-0,6

Tab.2. Average yearly production of metals from extracted and processed minerals.

Product - Metal	Average yearly output
Fe [t]	350.000-380.000
Cu [t]	5.300-5.800
Pb [t]	2.700-3.100
Zn [t]	5.300-5.600
Sn [t]	280-330
W [t]	25-32
Sb [t]	1.200-1.300
Hg [t]	140-170
Ag [t]	16-19
Au [kg]	80-110
Mn [kg]	21.000-22.000

As is indicated in the tables, almost all the yearly consumption of brown coal and lignite was covered by home production. Consumption of mineral oil and earth gas was covered by imports. These imports were more than 90%.

Covering of home needs were: Fe - 4%, Cu, Pb, Zn, Sn - 10 - 12%, Mercury - 75% and Sb - 100%.

1. Metalloid materials: barite, graphite, talc and flint - production was enough to cover home needs and some quantity was exported to other countries mainly to the former Eastern Block, but also to western countries. (Národohospodársky prínos rudného baníctva pre budúcnosť čsl. ekonomiky, GRBaMZ, Bratislava 1989)

In the case of the other raw materials, production covered almost all-home needs with small aberrance, which was managed by the production of other former eastern countries.

The production of magnesite had a special position, which has been from an export point of view a considerable commodity.

Value of realised production

All data are connected mainly with the year 1987. Revenues are calculated in consumer prices.

Metalloid materials: 767 475 000 Kčs (former Czechoslovak currency - Exchange rate Kčs: French Frank = 2,50: 1,00 (1987)).

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Iron and manganese 364 238 000 Kčs, other metallic and metalloid materials 928 845 000 Kčs together.

It is important to say, the state had to subsidise this production because of the high costs connected to production and processing. The Budget for this purpose was about 1 000 000 000 Kčs. For example in 1987 the state subsidy 1 166 979 000 Kčs and income from mining activities was 1 197 450 000. These figures show a considerable difference between executed output and real value for the state. (Ekonomická prognóza hornictví a hutnictví neželezných kovu, ČSAV, Praha 1988)

Economic changes and especially changes of ownership right, which Slovakia made since this time is the main reason for changing the economic evaluation of mining projects.

Mining - a unique investment environment

Certainly the investment environment associated with the mining industry is unique when compared with the environment encountered by typical manufacturing industries. Some characteristics of mining which are often proclamed as being unique are as follows:

1) Capital Intensity
2) Long Preproduction Period
3) High Risk
4) Non-renewable Resource

The economic evaluation of a project requires a great deal of diverse information to be brought together in one place. The greatest concern is that there will be an error by omission, so it is useful to have a detailed list of what one needs to know in order to make a thorough evaluation.

There are varying degrees of detail required at the different stages of evaluation in a project, from the "quick and dirty" overview to the pre-feasibility study, to a full detailed feasibility study, to a due diligence review. This list addresses most of the economic variables in a project and can be used for all levels of studies. Its purpose is to identify a variable or issue and to raise a question, which the review can then pursue in more detail using increasingly more comprehensive checklist for each topic. While developed from the point of view of a new project, this list is equally valid for an ongoing operation. (Cavender, 1992)

Economic Decision Making Model

A Decision to invest in mining industry need to have an apparatus for the effective judgement of all data. For this purpose several tools exist of which some are:

- design of a detailed economic study with rate of acceleration (screening)
- comparison of eligibility of all potential investment resources (ranking)
- evaluation of supply proposals from all potential suppliers
- decision to buy or to sell
- specification of value or price for buying or selling of product
- specification of capital and operating costs
- specification of costs for the loan resources
- replacement of existing equipment and services
- selecting of possible alternatives

A practical approach to an economic evaluation, just to understand internal connectivity, needs to perform the evaluation in steps. It is possible to see influences of the input parameters on the output results. In general it is reasonable to divide evaluation in to four steps:

Practical Economic Study of a Project

- Study of the project itself
- Effect of taxes - depreciation (amortisation)
- Borrowing and its effect on the project
- Study of the complete project (with taxes and borrowing)

A Flow diagram of the above-mentioned steps is set out in figure 1. - 5. Figure 6 presents the complete process of selecting the best alternatives.

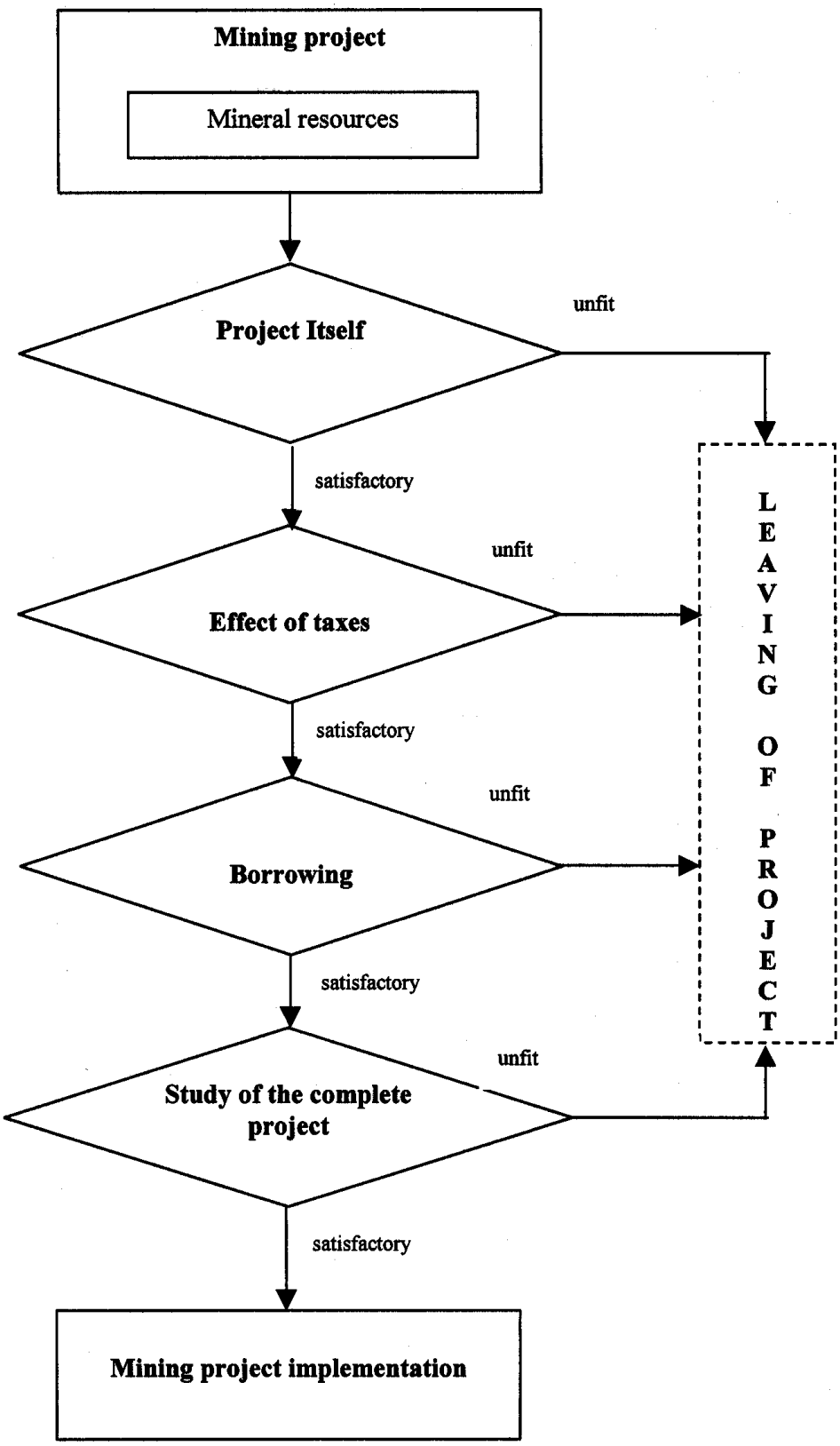

Fig.1. Economic evaluation of investment (project).

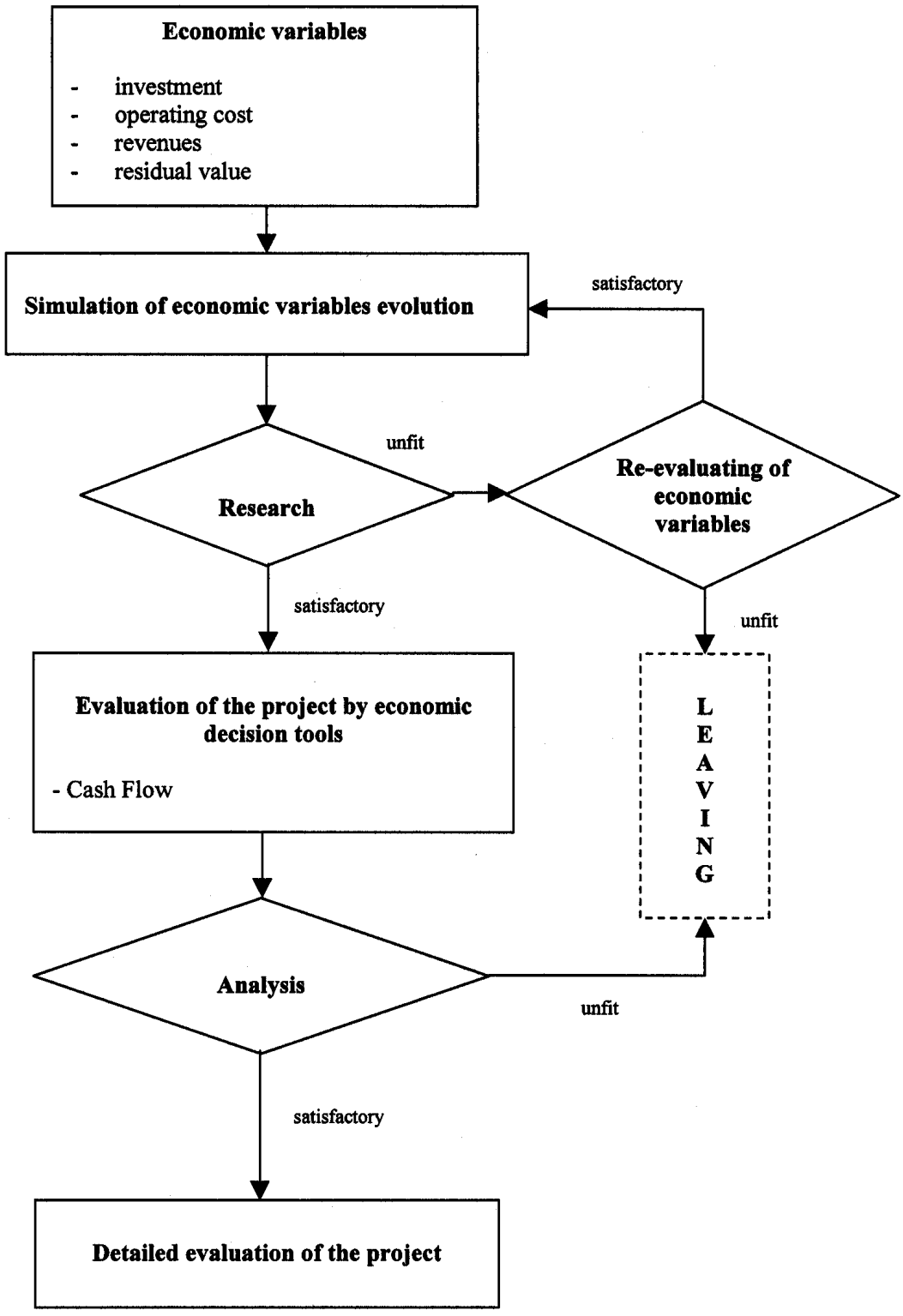

Fig.2. Project Itself.

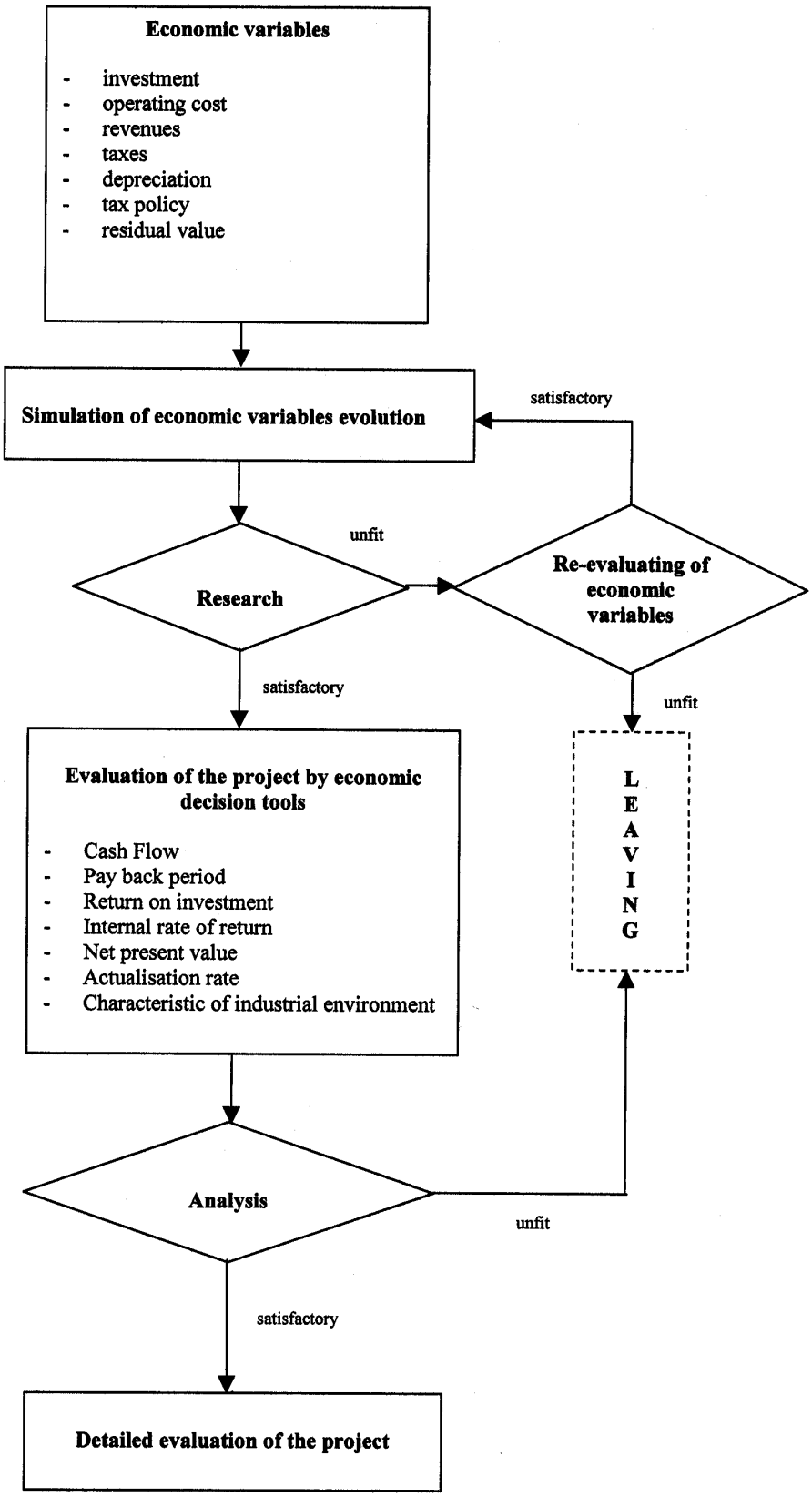

Fig.3. Effect of taxes and depreciation.

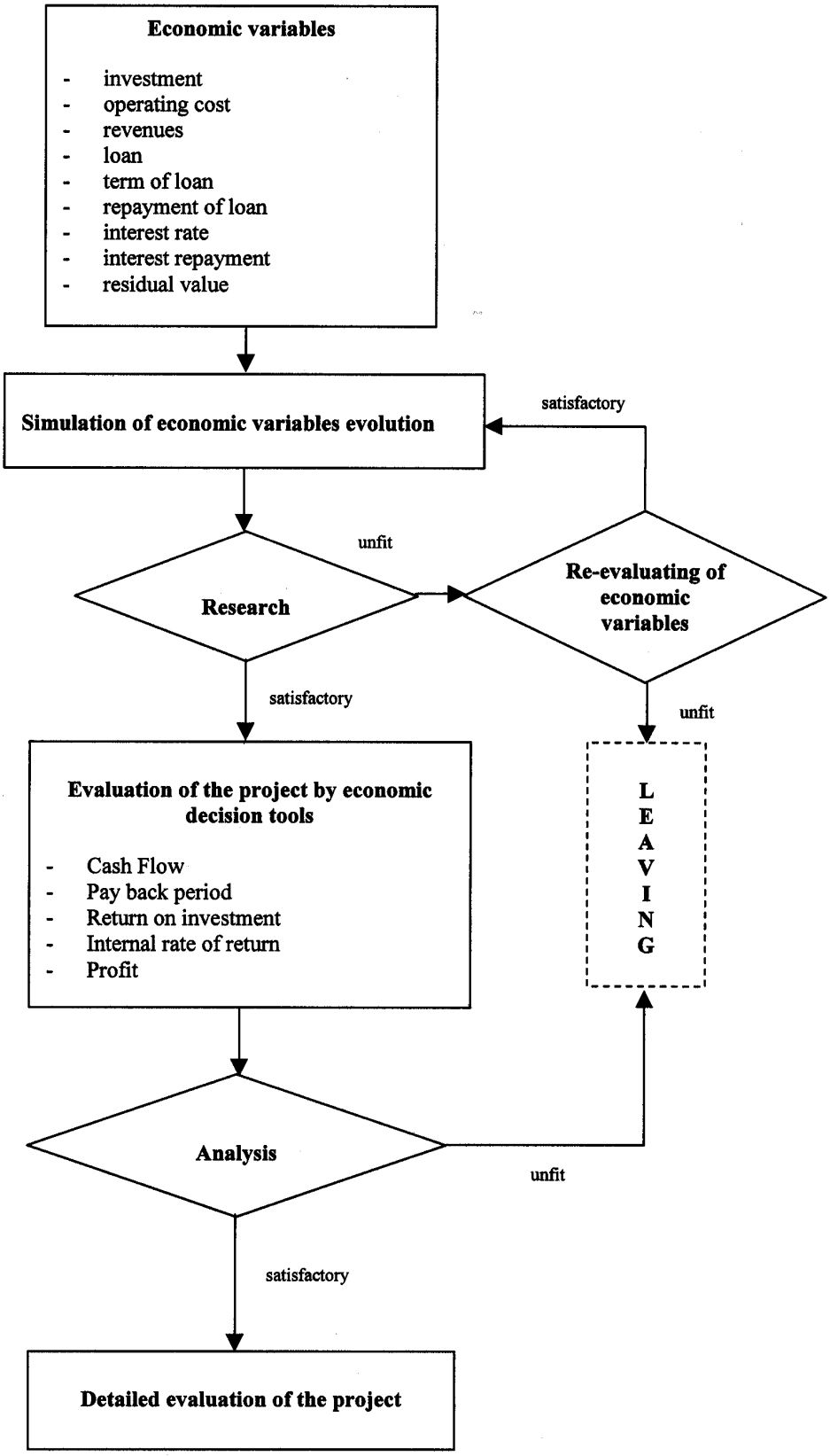

Fig.4. Borrowing.

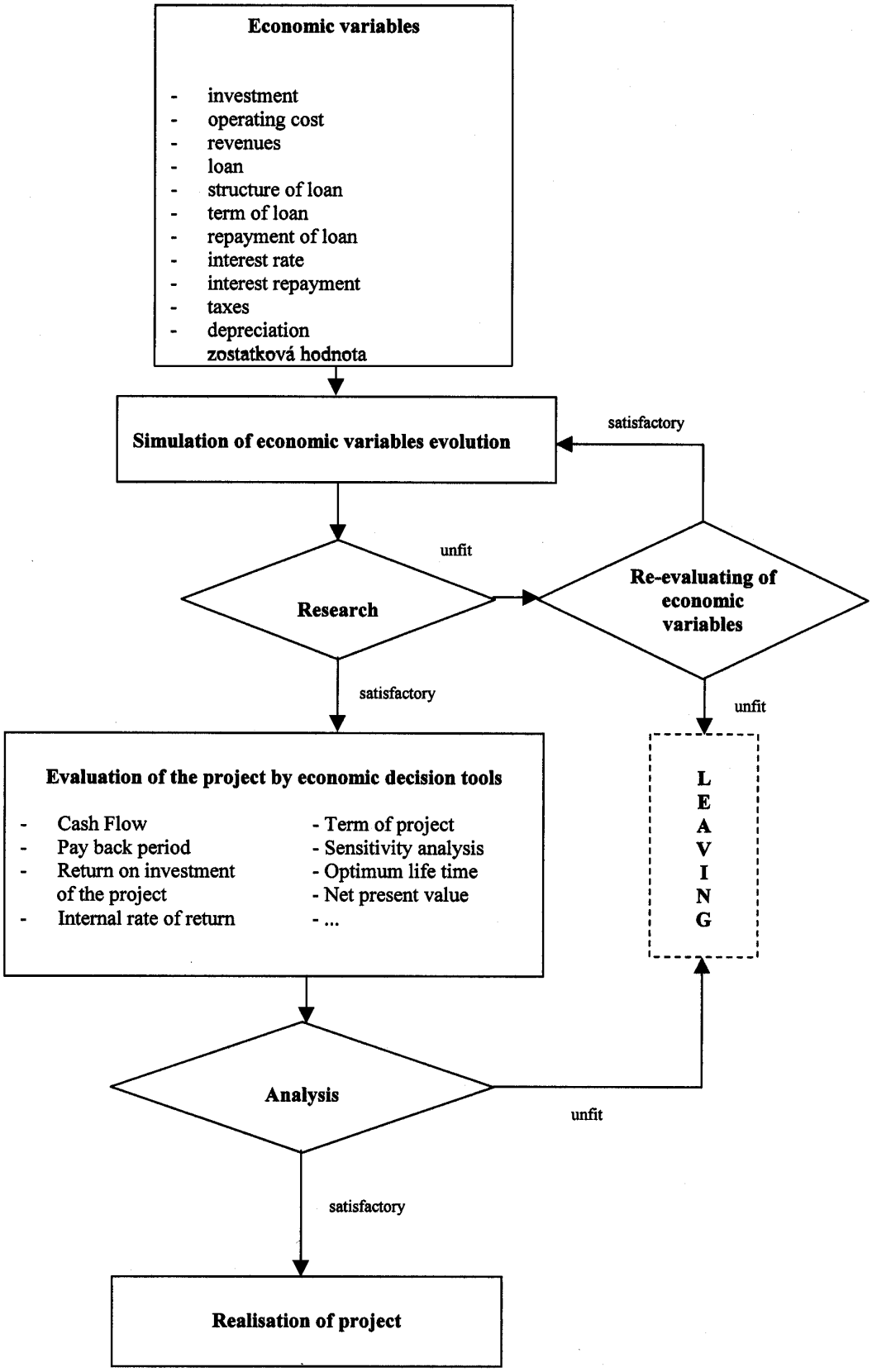

Fig.5. Study of the complette project.

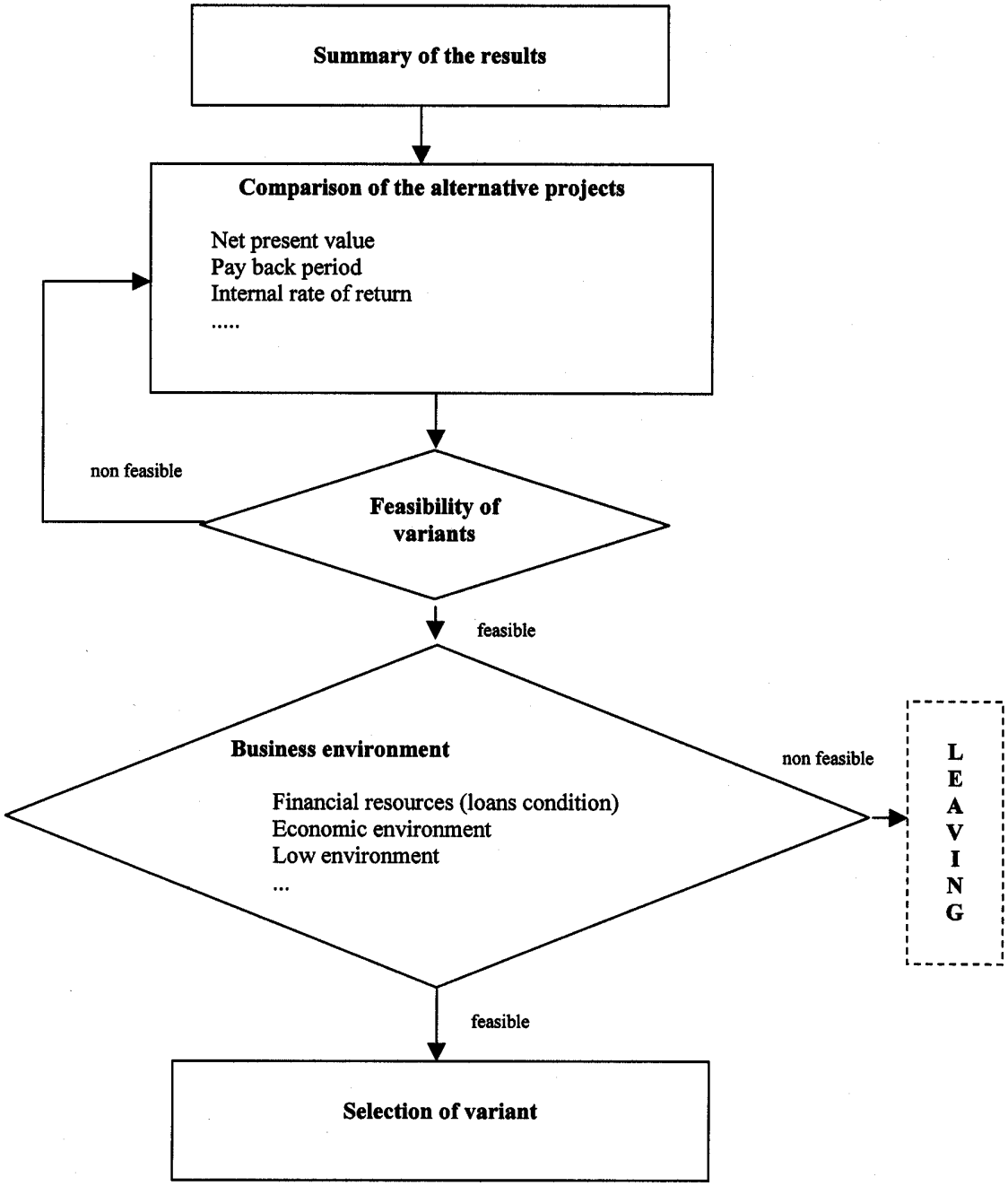

Fig.6. Analysis of the probable results of the project.

Feasibility study and tools for economic decision making

A feasibility study is defined as an assessment of all aspects of a project including technical, infrastructural, environmental, social, legislative and commercial factors, which is sufficiently detailed to support a decision on implementation.

Feasibility study should clearly define:

- The objective of the study
- The contents of a feasibility study
- The importance of a feasibility study

Study of project:

- preliminary investigation report
- order of magnitude study
- pre-feasibility study
- feasibility study
- detailed project report

Contents of the feasibility study:

- executive summary
- technical
- financial
- environmental

Executive summary

The feasibility report is condensed in this section into a few pages or a small separate volume, which gives an insight view of the project.

Each project has an associated level of risk. For a proposed investment to increase the value of a firm's stock, it should have a higher expected rate of return than shareholders require for assuming that risk. Since investors demand higher potential returns from a riskier project, the cost of capital depend on the venture's risk. Therefore, this must be quantified. The costs of capital also reflect interest payments on debt and the level of dividends and capital gains needed to satisfy shareholders. Given a proposed project's expected future cash flows, the risk level and the minimum rate of return required by the shareholders, the value of a potential investment can be calculated. Theoretically, this is accomplished by comparing the investment to others in the financial market. If the cost of a portfolio of securities with the same expected cash flow and risk level were less than the portfolio's value, the investment would be made. Practically, the present worth of the investment is calculated by estimating the present value of each of its expected future cash flows and then summing these present values. If the total or net, present value of the investment's future cash flow exceeds its cost, investment in the project can be expected to increase the firm's value. (Rybár, 2000)

Financial performance measures.

There are two primary performance measures used with discounted cash flows:

- net present value NPV
- internal rate of return IRR

Net present value

This measures projects expected profitability in terms of its estimated effect on the firm's market value. In other words, the net present value describes the financial gain (or loss), in current dollars, to be realised if the company proceeds with the project. It is important to note, that cash flows, not net incomes, are used in the calculation. Each period's length is usually chosen as one year.

A discount rate must be selected that adequately represents the project's riskiness. The discount rate consists of a base opportunity cost of capital, one increment for risks and another for transaction costs.

While the risk of an individual project is not as important to investors as the overall risk of the company's investment portfolio, it still plays a major role in determining the project's viability. (Fraser, 1993)

Since inflation can substantially reduce profitability, it must be included in valuation calculations. Its effects are magnified by the large scale and long lead times for project development. Inflation impacts the revenues to be generated by the project and the production costs. In addition, it increases the taxes and the amount of working capital required.

Inflation also affects the choice on appropriate discount rate. Merely adding the inflation rate to the other discount rate components implies that costs and product prices rise at the same rate and, therefore, offset each other. However, this is not true in practice and leads to artificially high NPVs and IRRs. A constant-dollar discount rate should be used when discounting constant dollar costs and revenues, while market-determined rate should be used for costs and revenues that have been adjusted for inflation.

$$NPV = \sum_{i=1}^{n} \left\{ \left[- I + CF_i \right] / (1 + a)^i \right\}$$

NPV - net present value
I - investment
CF - cash-flow
a - actualisation rate
i - actual year
n - term of project

Net present value can also be expressed by the equation:

$$NPV = (R_0 - C_0) + \frac{R_1 - C_1}{1 + a} + \frac{R_2 - C_2}{(1 + a)^2} + ... + \frac{R_n - C_n}{(1 + a)^n}$$

NPV - net present value
R - revenues
C - costs
a - actualisation rate
n - term of project

A different case could by a situation where it is necessary to use other money for a project. (Loan, ...).

$$NPVCI = \sum_{i=1}^{n} \left\{ \left[- (I - L) + (CF_i - rep_i) \right] / (1 + a)^i \right\}$$

NPVCI - net present value of capital investment
I - investment
CF - cash-flow
a - actualisation rate
i - actual year
n - term of project
L - loan
rep - repayment of loan

Depending on the results of the NPV it is also the possible to calculate pay back period. The Pay back period is the result of the equation where NPV is equal to zero.

$$\sum_{i=1}^{n} \left\{ \left[- I + CF_i \right] / (1 + a)^i \right\} = 0$$

I - investment
CF - cash-flow
a - actualisation rate
i - actual year
n - term of project

or

$$\sum_{i=1}^{n} \left\{ \left[- (I - L) + (CF_i - rep_i) \right] / (1 + a)^i \right\} = 0$$

I - investment
CF - cash-flow
a - actualisation rate
i - actual year
n - term of project
L - loan
rep - repayment of loan

Internal rate of return

This establishes a rate of return for the project, which can be compared to the returns on securities of similar risk in the financial market. The calculation provides the discount rate at which he NPV is equal to zero, and the project just breaks even. It is determined by setting the NPV of Eq. to zero, and solving the equation in the alternative fashion for the variable r. While the IRR is generally interpreted as the rate of return the project earns, it is actually the rate of return required by the market for the project to break even.

$$NPV = 0 = (R_0 - C_0) + \frac{R_1 - C_1}{1 + IRR} + \frac{R_2 - C_2}{(1 + IRR)^2} + ... + \frac{R_n - C_n}{(1 + IRR)^n}$$

NPV - net present value
R - revenues
C - costs
IRR - internal rate of return
n - term of project

Sensitivity analysis

The sensitivity of profitability measures (NPV or IRR) to changes in the underlying variables, considered one at a time, gives an indication of the degree of risk associated with that variable. By holding other parameters constant and changing the value of the variable of interest, the sensitivity of the financial results to those factors is measured.

Sensitivity analyses are most frequently conducted to determine the effects of variations in mineral prices, operating costs, initial capital investment and annual production grade. Price and operating cost are generally the most sensitive parameters. Figure 7 shows the influence of changing of basic input parameters on IRR.

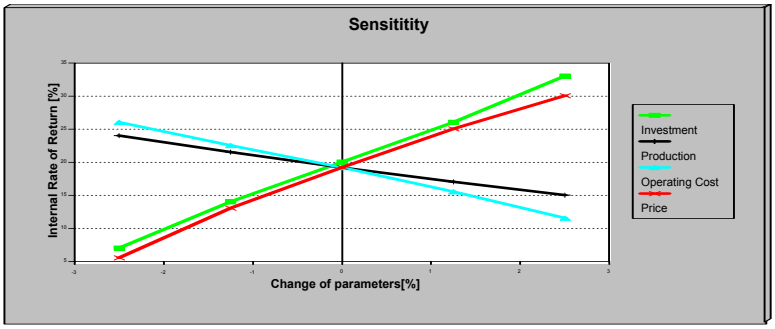

Fig.7. Influence of Investment, Price, Operating costs and Production rate on IRR.

Example of the economic study of project jv carnaudmetalbox

This project was distributed among three partners, CarnaudMetakbox (Fr), VSZ (Svk), CassoviaInvest (Svk). They distributed investment to create common project in Kosice (Svk) in area of heavy industry.

Investments

Total investment (100%) will be 56 100 KFF from which 27 450 KFF (49%) will be invested by CarnaudMetalbox, 27 450 KFF (49%) will be invested by VSZ and 1 200 KFF (2%) will invest CassoviaInvest.

CarnaudMetalbox will invest from 27 450 KFF in the first year 18 450 KFF and 9 000 KFF in the second year.

VSZ will invest from 27 450 KFF in the first year 23 950 KFF and 3500 KFF in the second year.

CassoviaInvest will invest 1 200 KFF, total quantity in the first year.

Cost of production

Personnel Cost: In it is included Monthly Salary for workers with tax, Social Insurance and Cars for management. The number of workers and the number of shifts in each department multiply all this.

Cost of production is divided into the three parts: cost of production for Ends, cost of production for Metal Sheet Slovakia, and cost of production for Metal Sheet Hungary.

Calculation is based on direct costs, indirect cost which are from production capacity, numbers of workers, material costs and on data, from the other branches of CarnaudMetalbox Alimentaire, which are located in France, Belgium and Hungary and are adapted to the technological conditions in Slovakia.

In operating cost are included all production costs per one unit of production and multiplied by the real production capacity which will be in JV KOSICE each year.

Revenues

Revenues are calculated as the result of the yearly production capacity and price per Sheet for Slovakia, Sheet for Hungary and Unit Ends.

Financial Analysis

The Calculating of Cash Flow (CF), Discounted Cash Flow (DCF), Sum of Discounted Cash Flow (SDCF), Net Present Value (NPV), Pay Back Period (PBP) and Internal Rate of Return (IRR) is done in the same way as was mentioned above.

First the "Project itself". Is calculated without the influence of the Taxes or the Borrowing. Only Investment, Revenues Operating Costs and Working Capital took part in this calculation. Working Capital is considered as the sum of Stocks (finished goods ends 1 month), Debtors (1 month sales) and Creditors (payment at 30 days).

Working Capital KFF

Year 1	Year 2	Year 3	Year 4	Year 5...
-6038	1657	-2691 -	2574	0

The second calculation "Effect of the Taxes" is to determine the influence of taxes. JV CarnaudMetalbox as a new plant has special Tax, guaranteed by Slovak Law, for the first two years the tax is 0%, therefore losses cannot be carried forward, for the second two years the tax is 30% and finally the tax is 40%.

Cash Flow is the result of Investment, Revenues, Operating Costs, Working Capital, Depreciation and Taxes.

This is project, which can be applied in Kosice.

Sensitivity study is done in case, project "Effect of Taxes", because all other calculations will try to follow same economical results. Sensitivity is done in interval ± 2.5% because in this plant the profit margin is in two cases 3% and in one case 9%. The second reason for this interval is, all important influence items on calculation are more or less fixed by management. There is small influence of the other environment.

Third calculation is done by influence of the Borrowing. Because in new JV CarnaudMetalbox is not considered borrowing, in calculation is chosen version 50% own Investment and 50% Borrowing. There is no time delay because production will start in the first year of the existing plant and it will bring Revenues. The term of borrowing is 10 years for each of the two loans, which are divided by the same rate as the investment. This is "Complete Project". The calculation is based on Investment, Revenues, Operating Costs, Working Capital, Depreciation, and Debt Service of Loans and Taxes. The aim of this calculation is to find at which interest rate borrowing is viable. It means that can bring at least the same result like without borrowing.

The calculation is done with a project lifetime at 25 years because the loan repayment term and the depreciation term, in order to see the influence, the disappearing of these items will have in calculating of Cash Flow. The lifetime of machinery project is difficult to estimate. It depends on market and supply possibilities.

Corporation tax

Tax Holiday (therefore losses cannot be carried fwd.)	
Year 1	0%
Year 2	0%
Year 3	30%
Year 4	30%
Year 5 ...	40%

The fourth calculation is again a complete calculation with Taxes and Borrowing, but the debt service is only 5 years. This means all borrowing must be repaid after five years. The aim is to see what influence the repayment time will have on interest rate with getting the same result.

The fifth simulation is similar to the fifth, but there we can see the influence of the amount of borrowing. It means the term of borrowing is 10 years but amount is only 25% op the total investment.

The last calculation is done according to what will happened if JV will borrow in Slovakia and which interest rate can be accepted if inflation of Slovak currency 10%.

Comment

8% was chosen as a discount rate, because the whole calculation is considered in French currency, in French Francs. This will simplify all business transactions between Slovakia, Hungary and France. Than if we consider, that the inflation of the French Franc is 2%, the interest rate of accounts is 5%, the difference is 3%. There is still a difference between the Franc "today" and "tomorrow" like the influence of the time where we can consider same rate 3%. The loss of changing between Franc and Crown is 2%.

Calcul.	Characteristics		NPV	PBP	IRR	Interest Rate
	Loan Term	Amount				of Loan
	[Years]	[%/invest.]	KFF	Y	%	%
1.	-	-	-	-	-	-
2.	0	0	2330	22.1	8.51	0.0
3.	10	50	2344	22.1	8.66	8.0
4.	5	50	2330	22.1	8.59	4.5
5.	10	25	2337	22.1	8.58	8.0
6.	10	50	2373	22.1	8.63	22.0

The first calculation showed the evolution of the sum of discounted cash flow. There is a visible positive evolution of the SDCF, the project is profitable and can bring back investment after some time along with some profit. We cannot draw any conclusion from this calculation because it is only a theoretical calculation. This only gives us first idea about CF evolution.

The second calculation with taxes we can take as the basic calculation which shows, that the project can be started. We are able to recover all investment and the whole time we have positive cash flow. This is important from the shareholders point of view. Now is the question of whether we are able to find better conditions for the project.

The sensitivity study which is made here is quite clear and says that the influence of the investment and production capacity on IRR is not high, neither is it high in the production as we know exactly our technology, production space and all other factors, we see that we can not invest more because in the production space there is no more space for more lines and our production capacity is limited by the technical capacity of the equipment. The operating cost per unit and the price per unit have the main influence. By only small moving we can earn or lose our money. But this must be precisely judged, because production is not final production and is used by the other branches of shareholder, also local strategy is not global strategy.

The third calculation tries to find, if we consider loan of 50% of investment and 10 years repayment, interest rate, with which this loan brings the same results as the project without a loan. It is possible if a loan is found with an interest rate of 8%.

The fourth calculation changed the conditions of the loan, amount of loan money is the same, but the repayment is only 5 years. This is a negative solution because if the project wants to earn the same money at the end, it is necessary to find a loan with 4.5%.

The fifth calculation changed the amount of the loan money to 25% of the investment only. Repayment is 10 years. With this condition we are able recover same money as with loan of 50% and a term of 10 years with 8%.

The last calculation tries to simulate which interest rate the loan should have if the project considers borrowing in Slovakia. There is a difference between Slovak and French inflation and it means that a loan with a higher interest rate than in France can be used. Inflation in France is 2% and for this year inflation in Slovakia ca be taken as 10%. Because of this we must discount our loan by 8%. In the calculation the project then gets loan as in the French conditions. The result is that if the project wants to earn money as in all the others cases except the fifth calculation it can take a loan in Slovakia with an interest rate max. 22%. Even though this case looks very promising, the reality is perhaps away, because the ideal situation is to keep only the loan under high inflation and all other economic in hard currency.

In general even in the best solution the NPV, PBP and IRR are quite debatable values. But even of that the machinery industry is not such a risky industry, and the term of these projects is usually quite a long time, sometimes a hundred years. There is always a guarantee of a positive CF in the year, which brings dividends to

shareholders. The input is more or less sure, because it comes from the biggest plant in Slovakia, whose main activity is the production of steel. The international network of CarnaudMetalbox guarantees customers for this production of JV CarnaudMetalbox. This is maybe as the most important advantage is the production of JV CarnaudMetalbox because of the relatively small profit margin, which can be used as worthwhile input to the other CarnaudMetalbox plants, which we can call profit making plants.

Conclusion

There is no doubt that the evaluation of new mining projects in today's environment, in the current economic climate, is much more complex than it was just a few years ago. There is typically a myriad variables which are directly or indirectly associated with the mine evaluation process. As such, mine valuation has become truly interdisciplinary in nature. An individual is rarely knowledgeable in all the areas involved in the evaluation process, particularly where major projects are being considered. In such economical conditions this is the preferred approach to the problem.

References

CAVENDER, B.: Determination of the Optimum Lifetime of a Mining Project using Discounted Cash-flow and Option Pricing Techniques. *Mining Engineering*. New York, 1992.

Ekonomická prognóza hornictví a hutnícтví neželezných kovu. *ČSAV,* Praha, 1988.

FRASER, H., A., RICHARD, D., S.: Economics of World-wide Petroleum Production. *Oil & Gas Consultants International, Inc.*, Oklahoma USA, 1993.

Národohospodársky prínos rudného baníctva pre budúci rozvoj čsl. ekonomiky. *GRBaMZ*, Bratislava, 1989.

RYBÁR, P., CEHLÁR, M., TRÉGER, M.: Oceňovanie ložísk nerastných surovín. *Štroffek*, Košice, 2000..