AGH Journal of Mining and Geoengineering • vol. 36 • No. 3 • 2012

Robert Ranosz, Arkadiusz Kustra**

ASSESSING THE PROFITABILITY OF AN UPGRADE INVESTMENT FOR THE COPPER ORE CONCENTRATION PLANT OF KGHM SA

1. Introduction

This publication presents the valuation of an investment at the Ore Concentration Plant (Polish abbreviation: ZWR) consisting in purchasing a new fixed asset. What is characteristic about this study is that the fixed asset currently in operation has not been fully depreciated yet and the reason why its replacement is considered it is the technological progress in this field. In this case, the ZWR can take one of three decisions: keep the machine in operation, use better consumables in its operation or purchase a new fixed asset. At the start it must be noted that the unit being assessed forms a part of a group which also includes mines (producing copper ore) and copper works. All costs associated with the production of copper and other precious metals at KGHM S.A. are accounted for in the so-called continuous cost. Thus individual units do not generate profit, while their costs are transferred to the following unit. Hence the costs of mines and ore concentration are taken over by copper works. This causes certain difficulties in valuing an investment using the NPV method. These are mainly due to the correct identification of individual cash flow items. There are no major problems in the case of cost items, but problems do appear when establishing the revenue from an investment made. In this publication, it was decided to measure the profitability of the investment using cash flows generated by a given investment option compared to the zero option (differential cash flows), which means that cash flows are determined which represent the difference between the cash flows generated by a specific investment option and the zero option, that is maintaining the current state without any change.

* AGH University of Science and Technology, Krakow

2. Analysis methodology

It was decided to assess individual investment options using the NPV method. To conduct a valuation using the NPV method, a decision must first be made on the structure of cash flows generated by the future investment. As the purpose of the analysis is to determine the profitability of a single investment project, there is no need to identify the complete cash flow (CF). In the case under consideration, a simplified Cash Flow structure can be used, namely FCFF (*Free Cash Flow to Firm*) or FCFE (*Free Cash Flow to Equity*). If the ZWR were to finance any part of its investment with external funds it would be right to use the FCFE structure, but if the entire project is financed with own funds, then the NPV can be determined based on the FCFF.

According to the traditional formula, the net present value is the total of present values of all annual cash flows minus the expenditure on the original investment. The NPV reflects the value of a project at a given discount rate and under a series of assumptions concerning cash flows. Thus the NPV is a measure of the value of the investment.

According to the current principles of interpreting the results of NPV calculations, an investment project is profitable if the NPV is greater than or equal to zero. A value greater than zero means that the rate of return on the investment (its profitability) is greater than the discount rate assumed for the calculation, which is an argument for implementing the investment project. If the NPV is below zero, then the investment is not profitable (the return on investment is lower than the assumed interest rate).

This method, just like many others, has many advantages and drawbacks. The main advantage of the NPV method stems from its universality and the fact that it can include cash flows from the entire lifecycle of the investment project. Its main drawback is that it does not demonstrate the relative profitability of the investment being assessed.

This disadvantage can be eliminated by using the net present value ratio — NPVR. The main benefit of using the NPVR is that we, as potential investors, can compare individual investment projects with one another (which is impossible if the simple NPV method is applied). This advantage stems from the fact that the NPV result is an amount (absolute), and the NPVR result is a percentage (relative). It can be generalised that the NPV value tells us whether the investment is profitable at all (NPV > 0), while the NPVR allows us to determine which of the selected (profitable) investments is the best for the investor. [1–4]

3. Example

The calculation result presented concerns an analysis aimed at determining the profitability of an investment in a new fixed asset. As the present fixed asset is operational (its lifetime is assumed at 7 years), one more option is considered in this example, namely: improving the present state by using better consumables for the machine operated now. Thus two options were identified in the analysed example:

— Option 1 — improving the present state by applying better consumables;
— Option 2 — investing in a new machine.

Here it should be noted that in fact, three options are taken into account. The third option that is taken into account but not analysed in the presented calculation example is to leave the current fixed asset without any upgrades. This third option, called the zero or baseline option, will be used to determine the differential cash flows. Taking into account the principles of assessing the profitability, the value of the differential NPV and cash flows in the context of this example, it should be assumed that if the NPV value is above zero, the investment or the use of better consumables will be justified (more profitable than the present state), whereas if the value is below zero, then keeping the current state is financially better for the Ore Concentration Plant. Obviously, the differential NPV will serve to determine the profitability of the investment in the context of the fixed asset used at present, but it will not be possible to find out which of the proposed solutions would be better for the ZWR. In order to be able to compare individual investment options, the methodology of the Net Present Value Ratio (NPVR) should be used.

As the calculated example concerns an element which directly impacts the quality and the lifetime of the entire technological line, in addition to a typical financial analysis, it is also necessary to carry out a risk analysis, i.e. an analysis of factors that are difficult to measure but are significant for taking the correct decision on executing the investment project. As this risk analysis is not the subject of this publication, it will not be presented in this calculation example, but should never be omitted when analysing this kind of options in a real investment project.

In order to analyse the profitability of an investment using the NPV, correct cash flows should be determined first. As the proposed example concerns an investment in a fixed asset which will be financed entirely with own funds, FCFF cash flows were chosen to establish the NPV. The main problem in determining the correct cash flows for the ZWR is that this unit does not generate revenue and its costs constitute the costs of the next entity, i.e. the copper works. In this analysis, the value of the technical cost of production from the base year (N) was treated as the revenue.

The investment profitability analysis is conducted mainly based on certain benefits resulting from changes introduced under particular options, which are reflected in the operating results of the ZWR and based on data about the cost of purchasing and deploying a new machine. Two options were analysed, which indicate the profitability of the investment in this fixed asset and upgrading the current machine by using better consumables.

In order to develop the right financial projection aimed at determining the NPV, it is necessary to assume baseline operating costs of the ZWR. For the purposes of this publication, the following operating costs of the Ore Concentration Plant, shown in Table 1, were assumed.

The only factor driving the change of the NPV consists in the generated costs. This assumption follows from the general principle that the ZWR does not generate revenue, and its costs are transferred to copper works.

TABLE 1

Baseline operating costs taken for the analysis [PLN million]

Labour	30
Ore for processing	1,000
Consumables	20
Energy	10
Depreciation	10
Maintenance	2
Other expenses	32

Source: own development.

In order to be able to calculate the example, certain assumptions must be made. These mainly concern the following variables:

— Investment expenditure (in the case of option 2);
— Cost of consumables;
— Cost of energy;
— Cost of maintenance.

The cost of purchasing a new fixed asset (the investment expenditure) was assumed at PLN 500,000. In this example it is also assumed that this asset would operate for 14 years, so the depreciation rate adopted for the analysis is 7.14%. The costs used for calculations in this analysis are presented in Table 2.

TABLE 2

Decreases/increases of individual cost groups under particular options [PLN]

	Option 1A	**Option 1B**	**Option 2**
Labour			
Ore for processing			
Consumables	40.000	40.000	50.000
Energy	0	0	40.000
Maintenance	–33.333	–50.000	–150.000
Other expenses	0	0	–18.000
Total	6.667	–10.000	–78.000

Table 2 above shows that two options are considered in the analysed example. In order to give a better picture of the problem discussed, option 1 is split into two cases (A and B) for analysing. Table 2 demonstrates how particular groups of costs decrease and increase. Negative values indicate that a given cost group has a positive impact on the operations of the ZWR, i.e. brings the operating costs down, positive values show that a given group of costs pushes the overall operating costs of the ZWR up. Individual values of costs presented in Table 2 apply to the options analysed. The following preliminary conclusions can be drawn based on the table. The calculations presented demonstrate that option 1A is the least profitable from the financial perspective as it generates the highest costs. In option 1, the cost of consumables will be PLN 40,000 higher than at present, while the maintenance cost will be over PLN 33 thousand lower. The reduction in the maintenance cost is due to the frequency of replacing the consumables: in the zero option it was assumed that consumables are replaced monthly, whereas in option 1A they are replaced 10 times a year. However, the reduction in maintenance cost does not offset the cost of purchasing consumables. In the analysed example it was also assumed that consumables will be replaced 9 times a year, and this is shown as option 1B. In this case, the maintenance cost will be reduced by PLN 50 thousand a year, so it will cover the cost of purchasing consumables. So even at this stage one can find that the replacement of consumables with higher quality ones depends on how often maintenance is done. In order for the investment in better consumables to be financially justified, these consumables must be replaced less than 10 times a year. In option 2, the total cost of operating this machine is PLN 78 thousand lower than that incurred at present. This reduction in the operating costs of the ZWR is mainly driven by the maintenance cost (this cost is PLN 150 thousand lower because in the new fixed asset, the consumables must be replaced 3 times a year) and other expenses (down PLN 18 thousand). The cost reduction in these two items significantly exceeds the cost increase due to the higher energy consumption of the proposed machine and the increased cost of consumables worn out. However, at this stage it is not yet possible to determine whether it is a better solution for the ZWR to purchase better consumables or a new machine. This dilemma stems from the fact that option 1B requires not investment expenditure, but only using better consumables, whereas the final assessment of the profitability of purchasing a new fixed asset is also influenced by the cost of its purchase and installation. It has been mentioned that the investment expenditure in option 2 is PLN 500 thousand, financed entirely with own funds. In order to account for this figure in the profitability analysis, one must calculate the NPV. As the individual options have to be compared with one another, the NPV must be calculated for the remaining options as well (options 1A and 1B).

Based on the data collected, differential FCFF cash flows were determined for individual options. The methodology and the results for individual options are presented in the following tables: Table 3 (option 1A), Table 4 (option 1B), Table 5 (option 2).

Tables 3, 4 and 5 present the methodologies used to assess the profitability of the investment under particular options. Depreciation is not included in Tables 3 and 4 as option 1 does not call for purchasing a fixed asset.

TABLE 3
Method of calculating the NPV for option 1A based on FCFF [PLN thousand]

	N	N + 1	N + 2	N + 3	N + 4	N + 5	N + 6	N + 7
Sales		0	0	0	0	0	0	0
Operating costs		5	5	5	5	5	5	5
(Operating) tax base (1 – 2)		–5	–5	–5	–5	–5	–5	–5
Income tax (19%)		0	0	0	0	0	0	0
Taxable operating result (3 – 4)		–5	–5	–5	–5	–5	–5	–5
Depreciation		0	0	0	0	0	0	0
Investment expenditure	0							
FCFF (5 + 6 – 7)	0	–5	–5	–5	–5	–5	–5	–5
Discount rate	1.00	0.97	0.94	0.92	0.89	0.86	0.84	0.81
NPV1A	–34							

Source: own development.

TABLE 4

Method of calculating the NPV for option 1B based on FCFF [PLN thousand]

	N	N + 1	N + 2	N + 3	N + 4	N + 5	N + 6	N + 7
Sales		0	0	0	0	0	0	0
Operating costs		–10	–10	–10	–10	–10	–10	–10
(Operating) tax base (1 – 2)		10	10	10	10	10	10	10
Income tax (19%)		2	2	2	2	2	2	2
Taxable operating result (3 – 4)		8	8	8	8	8	8	8
Depreciation		0	0	0	0	0	0	0
Investment expenditure	0							
FCFF (5 + 6 – 7)	0	8	8	8	8	8	8	8
Discount rate	1.00	0.97	0.94	0.92	0.89	0.86	0.84	0.81
NPV1B	50							

Source: own development,

TABLE 5
Method of calculating the NPV for option 2 based on FCFF [PLN thousand]

	N	N + 1	N + 2	N + 3	N + 4	N + 5	N + 6	N + 7
Sales		0	0	0	0	0	0	0
Operating costs incl. depreciation		–42	–42	–42	–42	–42	–42	–42
(Operating) tax base (1 – 2)		42	42	42	42	42	42	42
Income tax (19%)		8	8	8	8	8	8	8
Taxable operating result (3 – 4)		34	34	34	34	34	34	34
Depreciation		36	36	36	36	36	36	36
Investment expenditure	500							
FCFF (5 + 6 – 7)	–500	70	70	70	70	70	70	70
Discount rate	1.00	0.97	0.94	0.92	0.89	0.86	0.84	0.81
NPV2	180							

Source: own development.

Table 3 shows that operating costs are PLN 5 thousand higher than today, and this value results from the tax shield taken into account. If the tax shield were excluded from this case, NPV1A would amount to PLN –42 thousand instead of the actual PLN –34 thousand.

Based on these results it can be said that investing in a new fixed asset is justified. The NPV for this investment amounts to PLN 180 thousand. The use of better consumables for the current machine is a worse solution for the ZWR than the purchase of a new fixed asset. The worst choice is option 1A. When this option is considered it should be stated that from the financial point of view, it is a better solution for the ZWR to keep the system currently in operation and apply the consumables used so far. The analysis shows that it would be reasonable to replace the current consumables with new ones, but only on the condition that their replacement would be less frequent than 10 times a year. This is demonstrated by option 1B.

At this stage of the example it can also be stated that option 1A should be rejected. Further down in this example, options 1B and 2 are compared. For the person choosing the investment option, the information that the NPV is higher for option 2 than 1B is not sufficient. What helps in the final selection of the option is the NPVR.

The NPVR was calculated for investment options 1B and 2 using the data collected and the results obtained. The results are shown in table 6.

TABLE 6

Values of the NPVR for individual investment options

NPVR-1B	0.02%
NPVR-2	0.03%

Source: own development.

Table 6 suggests that it is better for the ZWR to implement option 2. This recommendation stems from the fact that the NPVR obtained for option 2 is 0.01 percentage point higher than for option 1B. However, it should be noted that if the consumables were replaced 8 times a year under option 1B, the NPV for option 1B would still be lower than for option 2, but the NPVR would be 0.02 of a percentage point higher, and then option 1B should be recommended.

4. Summary

This publication describes the method of valuing an investment for the Ore Concentration Plant (ZWR). The main purpose of this analysis was to answer the question whether it would be more profitable for the ZWR to purchase a new fixed asset, or just to upgrade the one currently operated by employing better consumables. It was decided to assess the profitability of the investment using the differential NPV and the NPVR. In order to correctly carry out the

analysis, it was necessary to estimate basic parameters such as the baseline cost and the effect of the changes introduced, which cause the operating costs to decrease or increase compared to their present level. In the case of option 2 it was also necessary to assume the amount of investment expenditure on purchasing and deploying the new machine. The assumed data was used to carry out the necessary calculations. For the assumed input data, the results obtained unambiguously indicate that the best option for the ZWR is to purchase a new machine.

It should be noted here that the methodology presented constitutes a simplified version and not a complete analysis of economic profitability, which should account for a broad range of parameters.

REFERENCES

[1] *Ranosz R.*: Ograniczanie wpływu zmienności cen surowców na wartość wyceny inwestycji górniczych Przegląd Górniczy; ISSN 0033-216X. — 2011 t. 67 nr 9 s. 129–131. — Bibliogr. s. 131

[2] *Ranosz R.*: Strefa zwiększonego ryzyka inwestycyjnego w wycenie inwestycji górniczych. Przegląd Górniczy; ISSN 0033–216X. — 2011 T. 66 nr 6 s. 23–26

[3] *Rogowski W.*: Rachunek efektywności inwestycji. Wydanie 2 poszerzone. Kraków. Wolters Kluwer Polska 2008

[4] *Sierpińska M., Jachna T.*: Metody podejmowania decyzji finansowych. Warszawa. Wydawnictwo Naukowe PWN, 2007.