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Use of Selected Derivatives For Valuation of Mining Investment Projects

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Abstract: The article is devoted to the issue of valuation of mining investment projects (with the use of the Monte Carlo method) via selected derivatives. The purpose of using such instruments in the process of valuation is to secure the revenue of a mining company by guaranteeing raw material prices. According to the authors of the publication, the use of such instruments will help reduce the variability of obtained results and increase their reliability. The article consists of four parts. The introduction to the article specifies the purpose of the work. The second part of the article presents the foundations for the analysis, the purpose of which is to compare the obtained results ofthe investment value for three variants. The first one assumes the use of financial options to secure raw material prices, the second assumes the use of futures, and the last one stipulates that the company does not take action with respect to securing raw material prices. The third part presents the results of the study. Due to the availability of data, sample calculations were carried out on the basis of the financial information published by a copper manufacturer. The obtained results show that from the point of view of the value of the investment and the risk of negative investment value, the most advantageous method is to secure the prices of raw materials in the process of valuation of mining investment projects with the use of options. The last part of the work is a summary presenting the conclusions of the analysis. The article is accompanied by a list of literature used to prepare this study.

1. Introduction

The problem of valuating mining investments has been the object of multiple analyses in Polish literature [5, 15, 16, 17, 20, 21] as well as foreign [1, 4, 8, 9, 11, 18]. These works draw attention to its multiple aspects. The most frequently discussed issues related to the valuation of mining investment projects are: the life cycle of an investment [12, 13], the manner of calculating the cost of equity and, in consequence, the discount rate or the forecast of raw material prices, as well as the costs of operating activity of a mining enterprise [6]. The above-listed issues are directly related to the method of valuation, i.e. the net present value, estimated on the basis of simplified cash flows. The methodology of calculating the net present value of a project (NPV) based on simplified cash flows is commonly known and has been the object of multiple studies [2,3,10, 19, 23]. The aspect of valuating mining investment projects to which the authors decided to pay attention to was the possibility of

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securing the volume of a company's revenues via prices of raw materials with the use of selected derivatives. The basic types of derivatives include futures, forward contracts, options and swaps. For the needs of the study, the authors focused their attention on the use of financial options and futures. Every derivative is composed of the so-called base instrument, which may be, e.g., the interest rate, the currency price or the price of a product (e.g. copper). According to the authors' experience, mining investment projects show greatest sensitivity to changes of prices of raw materials and costs of operating activity. In relation to the above, this study takes into account securing the volume of revenues via prices of products on international markets. This element is quite significant due to the fact that in the case of mining investment projects, the life cycle of a project reaches even 40 years, which makes forecasts of prices in such a period almost impossible. On account of this difficulty, the Monte Carlo method of analysis is often used in such cases where, based on the distribution of probability, a random choice of prices of raw materials and costs is made. The result of analysis is distribution of probability of the investment value and the so-called expected NPV (E(NPV)). Therefore, the objective of this article is to present the concept of using financial options and futures to valuate mining investment projects with the use of the Monte Carlo method. The point of reference for determining whether the proposed concept is justified is valuation of the same investment with the use of the same method, yet without the above-mentioned derivatives.

2. Assumptions for the Analysis

Due to the fact that the object of security are prices of raw materials, therefore both in the case of futures and options, such instruments need to have a short position, i.e. they have to secure a mining enterprise from a drop in prices of raw materials at international markets. The assumption adopted for the use of derivatives in the process of valuation of mining investment projects relies on the net present value and results in the necessity of including, in the net present value, both financial costs and revenues. In the case of futures, financial costs will appear when the price of raw materials is higher than the contract settlement price, whereas financial revenues will appear when the price of raw material applicable at a given moment is lower than the price of contract settlement. In the case of options, financial costs will only be related to the purchase of a relevant option package (option premium) at the beginning of a period (in the "zero" year) –in contrast to futures, financial costs will not appear during the term of the option, which results from its nature. The issuer acquires the right to exercise the option; thence, in the case of unfavourable price movements on international markets, a given option does not have to be exercised. Similarly to futures, financial revenues in the case of options will appear when the price of raw materials applicable at a given moment is lower than the price of exercising the option. Due to the fact that mining investment projects are most sensitive to revenues and costs of operating activity, in the Monte Carlo analysis, apart from variation of prices of raw materials, variability of costs of operational activity was also taken into account.

Sample calculation (the results of which are presented in the next chapter of this study) was prepared for a manufacturer of electrolytic copper. The samplewas prepared for the following initial assumptions:

- Duration of investment project: 7 years;
- Discount rate: 9%;
- Annual extraction volume: 10,000 Mg;
- Production cost of one Mg: PLN 20,000;
- Price of copper: USD 4,967.10 Mg;
- Price of American dollar: PLN 4.00;
- Option exercise price: USD 4967.10 Mg;
- Standard deviation of raw materials' prices: 45%;
- Risk free rate: 5%;
- Based on the presented data, the value of option premium was estimated in the amount of PLN 563,370.The mode of estimating the option premium has been the object of multiple studies[7, 14, 22].

Due to the fact that the performed analysis relies on the Monte Carlo method, it is also necessary to adopt assumptions with respect to the distribution of probability (table 1) both in regard to the variability of prices of raw materials and variability of costs of operating activity.

Table 1. Parameters determining individual types of distribution for adopted variables.

Variable	Type of distribution	Parameters describing distribution		
		Expected value		Standard deviation
Change in raw materials' prices	Normal	26%		41%
		Minimum	Most probable	Maximum
Change in operating costs	Triangular	-21.2%	16.1%	90.7%

Source: authors' own study

It has to be emphasised here that if the costs of operating activity were not taken into account in the performed analysis, then the value of the project assuming the use of futures to secure the price of raw materials would be fixed. It is also necessary to add that other factors that may influence the value of a mining investment project were not taken into account in the performed analysis. Such parameters may primarily include: fluctuation of American dollar prices, costs of capital (discount rate) or the volume of extraction.

3. Analysis

Relying on premises presented in the previous chapter, an analysis of the use of selected derivatives (options and futures) was performed in the process of valuation of mining investment projects with the use of the Monte Carlo method. The effect of the study is going to determine which form of securing the value of revenues of a mining company via the prices of raw materials is the most advantageous. The results will also show whether the use of derivatives in the process of valuation of mining investment projects is justified. Justifiability of the use of derivatives will also be determined by a comparison of the received results with the results of the investment which does not foresee such security. The effect of the analysis is a histogram of project value (figure 1) for individual forms of security, aprobability distribution function (figure 2) and the expected value of an investment project ((E(NPV)) (table2).

The first result of the analysis is a histogram presenting the probability distribution of a value of an investment project for individual forms of security (options and futures) and the value of investment where no security was used (no security) (figure 1).

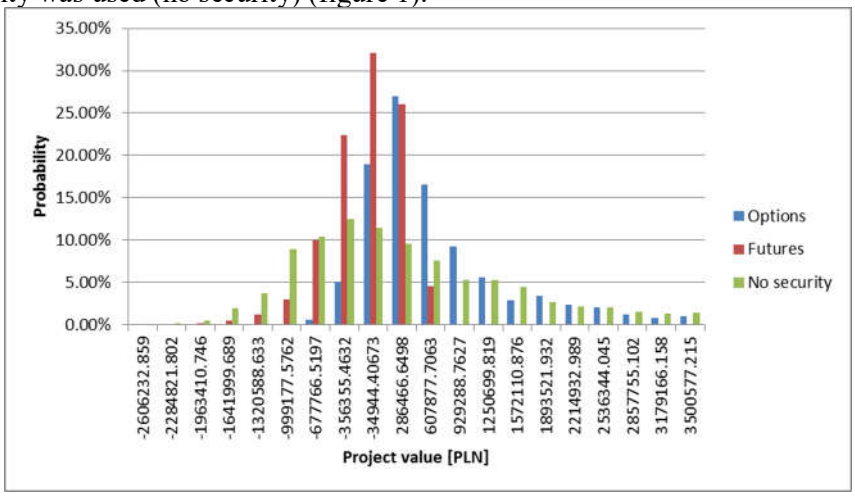


Figure 1. Histogram of project value (NPV) for individual forms of securing an investment project. Source: authors' own study.

The results presented in figure 1 assume the use of options as an instrument to secure the value of revenues of a mining enterprise via prices of raw materials and show that the probability of occurrence of negative NPV is more limited than if futures are used or when the enterprise does not take any steps to secure the value of revenues. It is also necessary to take into account the fact that the use of futures greatly prevents a company from participating in the increase of raw materials' prices at international markets, as opposed to options. Based on figure 1, it may be concluded that the use of options in the valuation of mining investment projects is justified, mainly due to the fact that this is a more advantageous solution than the use of futures.

Another result of analysis is the probability distribution function for individual forms of securing a mining investment project.

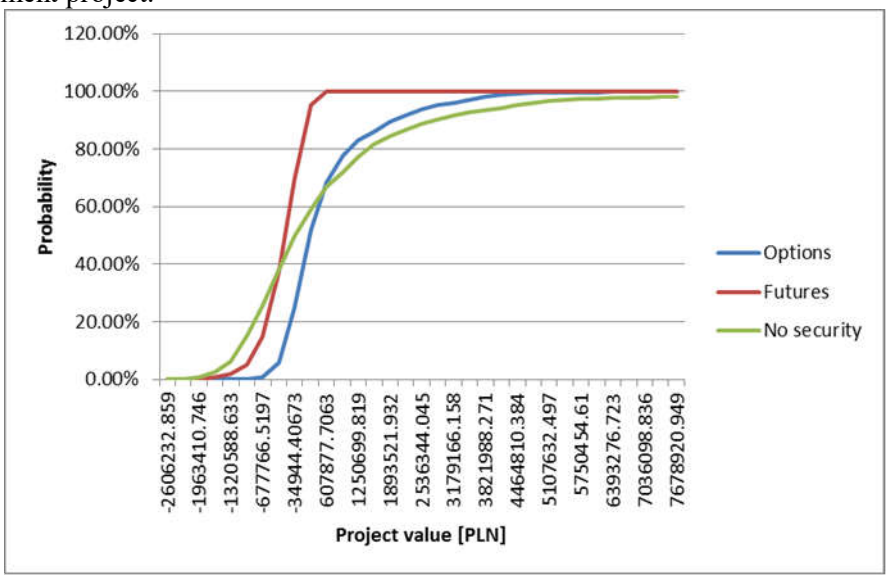


Figure 2. Probability distribution function for individual forms of securing an investment project. Source: authors' own study

The results presented in figure 2 show that the probability that a project is going to be unprofitable (negative values of an investment project) is different for individual variants (forms of security and the variant when the company does not secure the prices of raw materials). If options are used to secure the value of an investment project, the probability that the project will be unprofitable amounts to approx. 24%. In a situation when the company decides to use futures to secure the prices of raw materials, the probability of unprofitability of a project reaches almost 70%. In the variant examined last, the probability amounts to 50%. The result received for the futures variant is quite surprising; it may be justified by the fact that when prices are secured with the use of this instrument, they are "frozen"; in this case, the value of the investment project is determined by the variability of costs of operating activity. Similarly to the previous case, it is confirmed that options are the most favourable solution that may be applied for the valuation of mining investment project, due to the fact that the probability of losses is the lowest.

The last effect of the analysis is the value of expected NPV.

Table 2. Expected value of the project for individual forms of securing an investment project. Source authors' own study,

Variant	E(NPV)
Options	PLN 432 078.26
Futures	PLN - 247 234.39
No security	PLN 383 412.92

The results presented in table 2 corroborate that the use of options in the process of valuation of mining investment projectswith the aim of securing the value of revenues of a mining company via prices of raw materials is the most advantageous solution.

4. Recapitulation

According to the presented calculations, the use of options in the process of valuation of mining investment projects to secure the volume of revenues via prices of raw materials is the best solution among the proposed ones. However, it is necessary to remember about the premises on which the relevant calculations relied. Justifiability of the use of options results primarily from their character; as mentioned in the article, the issuer of options has a right – and not obligation – to exercise it; therefore, such option will be exercised if prices drop and if prices grow, the option will not be exercised and the mining company will participate in the growth of raw materials' prices. The issue discussed in this article should be the object of further studies.

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