Correct accounting of risks in assessing the effectiveness of investment projects of metallurgical companies

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Abstract. This article proposes the methodology that modifies the capital asset pricing model (CAPM). The proposed methodology allows for separate accounting of risks of the first and second kind and, accordingly, to correctly reflect them in the calculations using the discounted cash flow method. This makes it possible to adequately assess the effectiveness of investment projects and make informed management decisions.

1. Introduction
The implementation of investment projects (in the broad sense of the word) is the key to the continuous development and improvement of any – including metallurgical – companies. However, for metallurgical companies, a correct assessment of the effectiveness of projects is extremely important, since many projects are very large-scale, and the implementation of inefficient solutions leads to the inefficiency use of a large amount of resources. Moreover, the feasibility assessment of project implementation is based, as a rule, on the method of discounted cash flows, the application of which is based on the forecast of future cash flows. However, in accordance with the concept of the time value of money, not only the total value of the generated cash flows is important, but also their distribution over time. Therefore, the projected cash flows must be discounted to determine their current value, and this means the need to use a discount rate in the calculations, which is the amount of the required return for the owner of the capital.

2. The problem statement
In addition to mediating the temporary difference between the cash flows of different periods, in modern financial management practice, the discount rate is usually assigned one more function – taking into account the risks inherent in the estimated asset. However, the impossibility of an accurate and objective assessment of the risk magnitude leads to many diverse approaches to solving this problem.

Thus, the author of this article recommends to determine the required return on equity on the basis of a subject-oriented approach described in detail in [1–2], and, according to studies [3–8], the main method for determining the discount rate is the capital asset pricing model (CAPM).

However, regardless of the model used, the calculation method using the discounted cash flow method leads to a distorted accounting of risks if they are taken into account in the discount rate. Traditionally, the value (value) of an asset under the discounted cash flow method is calculated using the following formula:
\[ V = \sum_{i=1}^{n} \frac{FCF_i}{(1+k)^i}, \]  

\( FCF_i \) – net cash flow of the \( i \)-th period;  
\( k \) – discount rate.

Net cash flow, in turn, represents the difference between the inflows and outflows generated by the asset being valued. In this regard, all types of risk that affect the value of this asset can be grouped into two categories:

1) the risk that inflows will be less than expected (risk of the first kind);
2) the risk that outflows will be greater than the expected value (risk of the second kind).

It is these two types of risk that can lead to a decrease in net cash flow and, as a result, to the fact that the value (value) of the asset will be less than the expected value. Accordingly, it is these two types of risk that should be correctly taken into account in the calculations. Consider whether this is true. To do this, we will consider formula (1), taking into account that the net cash flow consists of inflows and outflows, and the discount rate consists of a risk-free component and a risk premium:

\[ V = \sum_{i=1}^{n} \frac{FCF_i}{(1+k)^i} - \sum_{i=1}^{n} \frac{CFP_i}{(1+k_f+k_r)^i} - \sum_{i=1}^{n} \frac{CFN_i}{(1+k_f+k_r)^i}, \]

\( FCF_i \) – net cash flow of the \( i \)-th period;  
\( k \) – discount rate;  
\( CFP_i \) – inflows of the \( i \)-th period;  
\( CFN_i \) – outflows of the \( i \)-th period;  
\( k_f \) – risk-free rate;  
\( k_r \) – risk premium.

We see that this approach only correctly takes into account the risk of the first kind – an increase in the risk premium leads to a decrease in the discounted value of the inflows, but at the same time also reduces the discounted value of the outflows. Thus, the risk of the second kind is not taken into account correctly. It turns out that such an approach is not applicable for evaluating assets that generate not only inflows, but also outflows, and the risk accounting methodology in the discount rate requires the introduction of new tools that would correctly take into account risks of both the first and second kind.

3. Methodology and research results

Since the most popular and frequently used model for determining the discount rate based on risks is CAPM, this work proposes a methodology for adapting this particular model to correct account of risks of both the first and second kind when discounting cash flows. The basic formula of this model, which allows the required profitability to be determined, is as follows:

\[ k = k_f + \beta \ast (k_m - k_f), \]  

\( k_f \) – risk-free rate;  
\( k_m \) – return on market portfolio;  
\( \beta \) – beta ratio.

Theoretically, the beta coefficient is defined as the ratio of the covariance of stock returns with market portfolio returns and the variance of market portfolio returns:
\[ \beta = \frac{COV(k; k_m)}{\sigma_m^2}, \]  

\[ COV(k; k_m) \] – covariance of stock returns and market portfolio;  
\[ \sigma_m^2 \] – variance of return on market portfolio.  

In practice, the beta coefficient is usually defined as a regression coefficient, in which the risk premium for the market portfolio is the explanatory factor, and the explained risk premium for the asset being assessed is:

\[ k - k_f = \beta \ast (k_m - k_f), \]  

This approach to determining the required return, as was shown above, distorts the results of applying the discounted cash flow method in the case of assets that generate both inflows and outflows. For adequate discounting of cash flows of an investment project, business, etc. it is necessary to divide the risk of the asset, assessed by the beta coefficient, by the risk of the first (decrease in inflows) and second (increase in outflows) kind. The usage of the CAPM model to estimate the required return when discounting cash flows generated by real assets suggests that the risk of the company shares (estimated by the beta coefficient of its shares) is comparable to the risk of cash flows generated, for example, by an investment project.

Thus, the risk of fluctuations in the market value of company shares is equal to the risk of fluctuations in the value of cash flows of a real asset. Leaving the validity of this assumption outside the scope of this study, we can assume that in this case, fluctuations in stock returns and the beta coefficient are quite capable of adequate reflection of not only the risk of a business or investment project, but also the risk of both the first and second kind. For this, it is necessary to separately calculate two beta coefficients: a beta coefficient for positive cash flows (inflows) and a beta coefficient for negative cash flows (outflows). In this case, the beta coefficient for the inflows should be determined on the basis of observations with a positive stock return, and the beta coefficient for the outflows should be determined on the basis of observations with a negative stock return. Thus, to find two beta coefficients, it is necessary to build two regression dependencies. Consider the algorithm for finding discount rates on the example of one of the largest Russian metallurgical companies: PJSC MMC Norilsk Nickel.

To calculate the traditional beta coefficient, we used data on the weekly risk premium for the shares of this company (the difference between the yield on shares and government bonds) and the weekly market risk premium for the risk, calculated as the difference between the yield on the MICEX market index and government bonds (OFZ). To build the regression dependence, we used data from the last five years (07/01/2014 – 06/30/2019), which provided 260 observations, the beta coefficient was 0.99. It should be noted that the return on the risk-free asset (federal loan bonds) was adopted at the level of 7.01% per annum, the yield on the market portfolio (calculated by the IMOEX index) was 14.24% per annum. Using the above data, it is possible to determine the value of the required yield by the traditional CAPM model:

\[ k = k_f + \beta \ast (k_m - k_f) = 7.01\% + 0.99 \ast (14.24\% - 7.01\%) = 14.17\%, \]  

The same observations were used to determine two beta coefficients reflecting two different types of risk, but only the observations with positive values (138 observations) were used to determine the beta coefficient of inflows, and for the outflow beta coefficient – with negative values (122 observation) risk premium on shares of Norilsk Nickel. Based on the constructed regression dependencies, the beta coefficient of inflows was 0.564, and the beta coefficient of outflows was 0.432. Accordingly, the discount rate for inflows can be determined by the formula:

\[ k_p = k_f + \beta_p \ast (k_m - k_f) = 7.01\% + 0.564 \ast (14.24\% - 7.01\%) = 11.09\%, \]
\[ k_r \] – discount rate for inflows;
\[ \beta_r \] – beta coefficient of inflows.

When determining the discount rate for outflows, the risk premium should not be added to risk-free profitability, but, on the contrary, subtracted from it.

\[ k_n = k_f - \beta_n \cdot (k_m - k_f) = 7.01\% - 0.432 \cdot (14.24\% - 7.01\%) = 3.89\% , \] (8)

\[ k_s \] – discount rate for outflows;
\[ \beta_s \] – beta coefficient of inflows.

Let us consider the mechanism of applying two discount rates on the example of a conditional project. Suppose PJSC MMC Norilsk Nickel intends to implement a three-year project that requires an initial investment of 100 million rubles. Project inflows over the years will amount to 150, 250 and 200 million rubles, outflows – 100, 150 and 120 million rubles. Calculate the net present value of the project (NPV).

In the case of applying the traditional CAPM model, it is necessary to discount the project’s net cash flows at a rate determined by formula (6) – 14.17%. The calculations are presented in table 1.

|                  | 0   | 1   | 2   | 3   |
|------------------|-----|-----|-----|-----|
| Initial investment | 100 | -   | -   | -   |
| Inflows          | -   | 150 | 250 | 200 |
| Outflows         | -   | 100 | 150 | 120 |
| Net cash flow    | -100| 50  | 100 | 80  |
| Discounted Net Cash Flow | -100| 43.8| 76.7| 53.8|

The amount of the discounted cash flows (NPV of the project) when calculated according to the traditional CAPM model is 74.3 million rubles.

When applying two discount rates, it is necessary to separately discount the inflows and outflows, and then find the difference between them to determine the discounted net cash flow. The calculations are presented in table 2.

|                  | 0   | 1   | 2   | 3   |
|------------------|-----|-----|-----|-----|
| Initial investment | 100 | -   | -   | -   |
| Inflows          | -   | 150 | 250 | 200 |
| Outflows         | -   | 100 | 150 | 120 |
| Discounted inflows | -   | 135,0| 202,6| 145,9|
| Discounted outflows | -   | 96,3 | 139,0| 107,0|
| Discounted net cash flow | -100| 38,8| 63,6| 38,9|

The amount of discounted cash flows (NPV of the project) when calculating using two discount rates is 41.2 million rubles.

As can be seen from the calculations, when applying two discount rates, the NPV of the project is lower by 33.1 million rubles, or almost twice. Obviously, the incorrect accounting of risks of the second kind when using a single rate leads to an overestimation of project indicators, as well as an overestimation of the value of any other valued asset that generates not only inflows, but also outflows.

4. Conclusion

Thus, as shown above, the application of the proposed methodology avoids overstatement of project performance indicators and, as a result, the implementation of inappropriate management decisions.
And this, in turn, makes it possible to manage the available resources more effectively and direct them to the projects implementation that are most beneficial for the metallurgical company, taking into account all risks.

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