Formation of Cash Flow-Based Factor Models in the System of Value-Based Management

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Abstract. The article considers the issues related to assessment and management of company value. It justifies the need for applying economic-mathematical modeling for company valuation in order to let companies manage their values. The authors propose models for calculating cash flow based on income and investment flows, calculating weighted average price of invested capital based on equality of the results of applying discounted cash flow method and economic value added method to company valuation, and calculating the factors affecting income and investment flows based on structural shifts method taking into account deviations from the average. The developed models of cash flows and calculation of weighted average cost of invested capital have been tested using actual data from three Russian high-tech companies. The sampling included a wide range of companies with revenues over two billion rubles: an industry leader, a company in the middle of the range, and a company at the lower boundary of the range. The calculations made it possible to analyze and compare the key performance indicators of the enterprises: rate of return, Tobin's ratio, fundamental value, equity share in capitalized value, effective income tax rate, etc. Classification of indicators according to the levels of their factorial influence on the final company value figures has been developed. The study has led to a conclusion that there is a need to employ the company's value analysis for interpreting results of companies' financial and economic activities, since the calculations performed have allowed assuming that conventional indicators of financial and economic analysis cannot fully evaluate a company's performance. The proposed models for assessing and managing companies' values make it possible to carry out theoretical calculations automatically.

1. Introduction

The relevance of the study derives from the fact that in modern conditions it becomes a common practice to use not only classical methods of financial analysis of a company performance, but to supplement them with enterprise value analysis. From the investors' point of view, a company performance is usually evaluated through the return on invested capital. Thus, an investor-owner (shareholder) assesses the company performance taking into account the gain of the invested capital value. Enterprise value commonly refers to estimation of the capital invested by shareholders.

In modern financial management, running a company [1-2] with the purpose of maximizing its value is called value-based management (VBM). Such management is based on the effective generation of income flows oriented towards investors, and investments in fixed and working capital,

leading to an increase in company value. These issues are inseparably linked with those of a company's objective valuation [3-7]. However, in spite of availability of a sufficient number of methods for assessing and managing company value, many urgent problems remain unsolved. Among them are the issues of forming a toolkit for calculating income and investment flows, defining company value, and the factors shaping the subsequent management decisions related to the increase in company value and, consequently, the growth of a company's efficiency [8]. This explains the value of the present study.

2. The level of progress in the subject research

The theory and practice of company value assessment and management have been studied and described in the works of many Russian and foreign scientists. Among the Russian researchers are D.L. Volkov, V.G. Kogdenko, M.V. Melnik, I.V. Ivashkovskaya, V.N. Starinsky, A.G. Untter, M.A. Fedotova, Yu.V. Trump, S.V. Valdaytsev, S.A. Smolyak, et al. The foreign economists whose works are used for this study include T. Copeland, A. Damodaran, T. Koller, N. Antill, K. Lee, and others.

The novelty of the research is the development of economic and mathematical models for assessing company value and identifying the factors which determine the influence of cash flows on enterprise value.

The purpose of this study is to develop efficient tools for solving the key problems of raising business activities' efficiency in terms of decision making in corporate value-based management. To achieve this goal, the following tasks have been accomplished:

1) to propose and test an economic and mathematical model for calculating the rate of return (weighted average cost of invested capital), used in assessing fundamental value of the company;

2) to offer economic and mathematical models of the influence of free cash flow to firm factors on the company value.

The theoretical relevance of the work concerns systematization and clarification of theoretical assumptions in terms of methodological approaches to calculation of key indicators used in assessing and managing Russian companies' values. The key hypothesis of the study is the statement that in the modern economy only the company's value analysis can provide a correct and objective interpretation of results of a company's economic activities.

The practical relevance is to test the developed economic and mathematical models with the use of the data from actual Russian companies. In particular, the paper discusses the possibility of obtaining reasonable forecasts of such key indicators of companies' economic activities that determine company value, such as earnings before interest and tax (EBIT), invested capital (IC), effective tax rate (ETR), etc. The requirements of accuracy and validity to applying the corresponding analytical models should, however, be given a priority in these model calculations. The economic and mathematical models proposed in the article as well as the criteria for management decisions make it possible to more objectively assess company performance, which is of particular importance in crisis conditions.

3. Research methodology

The framework of the study included three main stages. The first one consisted of selecting a company's value indicator and constructing a cash flow model to be used for calculations. During the second stage an economic-mathematical model for calculating the weighted average cost of capital (WACC) was developed and tested using the actual companies' data. The third step was construction of an economic-mathematical factor model of free cash flows to firm (FCFF) influence on the enterprise value.

The research methods used in the study comprised the method of ascent from the abstract to the concrete, the methods of comparison, observation and scientific generalization. The method of ascent from the abstract to the concrete was chosen, since theory was to be translated into practice, namely the study of specific companies. The comparison method was employed as the most important analysis method, which, in particular, allowed evaluating certain aspects of companies' activities and their efficiency using comparison of absolute and relative values. The method of observation was applied

since the research provided observation of real objects, namely some Russian companies. The method of scientific generalization was used, because it is a logical process of transition from the individual to the general, in this case, to the specifics of the functioning of individual companies on the whole.

In addition, in order to conduct model calculations, specific econometric methods were used: approximations and extrapolations involving development of linear trends, statistical estimation of forecasts' reliability, and numerical solutions of nonlinear equations.

4. Methodology of factor cash flow model

VBM uses the index of fundamental value as a measure of company value. The choice of this value type was justified, among others by Volkov D.L. in [9]. The fundamental company value (*V*) relates to the value which is received by a calculation based on capitalization of all future possible incomes of the company (excluding unsystematic investors' risks), expected from the data of financial statements obtained before the valuation date. The calculations are based on the classical discounted cash flow method and the terminal value accounting method using the Gordon model (formula 1) [10]:

$$V = \sum_{i=1}^{n} \frac{FCFF_i}{(1+DR)^i} + \frac{FCFF_n \cdot (1+g)}{(1+DR)^n \cdot (DR-g)} - D_0 \; , \tag{1}$$

where
i – year number after the valuation date;
n – number of years within the forecast period;
$FCFF_i$ – free cash flow to firm of the *i*-th forecast year;
DR – discount rate;
g – long-term capital gain rate in the post-forecast period;
D_0 – debt (borrowed capital value) as of the valuation date[1].

Free cash flow to firm is the forecast free cash flow, which may be aimed at all the company's investors. In order to determine the fundamental value, we should calculate the difference between the incomes that can be aimed at all investors and the increase in the capital put by all the investors [11, 12]. The formula for the calculation is given in [13] (formula 2):

$$FCFF_i = EBIT_i \cdot (1-ETR) - (IC_i - IC_{(i-1)}) \; , \tag{2}$$

where
$EBIT_i$ – earnings before interest payment and income tax of the *i*-th forecast year [2];
ETR – established meaning of effective taxation rate of company's income [3];
IC_i – estimated value of the invested capital of the *i*-th year, adjusted for the amount of surplus or lack of working capital.

The fundamental difference of the chosen model for calculating cash flows from the generally accepted models in assessment of enterprise value is the use of net income flows, which can be aimed at all investors and the flow of external investments. In traditional assessment approaches for calculating cash flows the free cash flow formula uses the indicator of capital investments and the indicator of changes in the required working capital for all investors [14].

When calculating the fundamental company value, the discount rate is assumed to be equal to the weighted average cost of invested capital (formula 3) [10]:

$$DR = WACC \tag{3}$$

The value of weighted average cost of invested capital is calculated from the model proposed by V.A. Shcherbakov [13] which is based on the concept of equality of company value, determined by

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[1] Calculated according to the document "Balance sheet" on the valuation date as the sum of the lines "Loans payable" (section 4) and "Loans payable" (section 5).
[2] Calculated on the basis of the linear trend of reported data (sum of the lines "Profit before tax" and "Interest payable" from the document "Profit & Loss Account").
[3] Calculated as the amount of actually paid income tax divided by the amount of profit before tax from the document "Profit & Loss Account".

the discounted cash flow method as well as the method of discounted economic value added (EVA) of a company, justified by N. Antilla and K. Lee (formula 4) in [15]:

$$\sum_{i=1}^{n} \frac{EVA_i - FCFF_i}{(1+WACC)^i} + \frac{(EVA_i - FCFF_i) \cdot (1+g)}{(1+WACC)^n \cdot (WACC - g)} + IC_0 = 0 ,\tag{4}$$

where

EVA_i – economic value added created in the i-th forecast year (formula 5) [16]:

$$EVA_i = EBIT \cdot (1 - ETR) - WACC \cdot \frac{IC_{i-1} + IC_i}{2}\tag{5}$$

The formulas (2) and (5) show that cash flows affect the company value both directly (first level factor of influence) and indirectly through the weighted average cost of attracted capital (second level factor) [17]. The indirect influence of cash flows on the company value is understudied in the modern Russian literature on VBM.

To verify these statements, we analyzed the financial performance of the companies united in an industry group of companies by type of activity in accordance with OKVED[4] 26 – "Manufacture of Computers, Electronic and Optical Products" with annual revenue of more than two million rubles. The analysis was based on comparison of the financial indicators of the Russian enterprises comparable in size, with the revenues exceeding two billion rubles. The research (2017) involved 89 enterprises.

In order to test the developed models, a sample group of three companies underwent rapid valuation test (open source data was used):

1. JSC "Novosibirsk instrument-making plant", with the purpose to make a comparative analysis of cash flows' effect over some years. Value calculations were carried out as of December 31st in the years of 2015, 2016 and 2017.

2. LLC "Production company Aquarius" and JSC "Elatomsky instrument plant"; value calculations were performed as of December 31, 2017.

As stated above, the hypothesis of this study was that the traditional indicators used in the analysis of financial and economic activities do not allow to fully evaluate the performance of an enterprise. What should be taken into account is the value increase, but for high-tech companies, these are specific factors affecting their performance.

To test the hypothesis, we carried out value calculations of the high-tech company JSC "Novosibirsk instrument making plant" as of December 31st in the years of 2015, 2016 and 2017. The open source company data[5] shows the overall positive dynamics of profitability and liquidity. Thus, from 2012 to 2016 the current liquidity ratio increased from 1.2 to 3.1 (at a rate of 1.5-2 and above). Profitability of sales, equity and assets also increased from 8% to 14.1%, from 2% to 7% and from 1.3 to 3% respectively. At the same time, the calculations showed that the weighted average cost of attracted capital decreased, and the company value fell down. The results of the calculations are shown in Table 1.

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[4] OKVED is All-Russian Classification of Economic Activities.
[5] http://www.audit-it.ru/buh_otchet/5402534361_ao-shvabe-oborona-i-zashchita

Table 1. Value indicators for the company under study. JSC "Novosibirsk instrument-making plant".

Indicator	Index	Evaluation Date		
		31.12.2015	31.12.2016	31.12.2017
Weighted Average Cost of Capital, %	WACC	23.28	17.07	7.29
Fundamental Value of the company, thousand rubles	V	1,700,647.9	631,526.4	6,766,102.2
Tobin rate[5],%	Q	76.28	25.89	233.67
Free Cash Flow to Firm (total cash flow to investors for the three years preceding the valuation date), thousand rubles	FCFF	2,432.2	-621,808.8	768,889.7
Equity, thousand rubles	E	2,226,621.0	2,438,868.0	2,895,588.0
Debt[6], thousand rubles	D	1,000,999.5	1,761,350.5	811,150.0
Financial Leverage [7], units	FL	0.4943	0.7222	0.2801
Invested Capital [8], thousand rubles	IC	3,327,349.0	4,200,218.5	3,706,738.0

Source: compiled by the authors based on the materials obtained.

Thus, JSC "Novosibirsk instrument engineering plant" reveals some specific features of financial management of high-tech companies, which consist in increasing investments (see the growth of invested capital in Table 1) in order to renew technological and product capacity of the enterprise. According to the company's open data (cash flow report), the revenues from the received loans and borrowings increased significantly (from 1,065.3 million rubles in 2015 to 2,585.3 million rubles), while the gains from issue of shares were insignificant (from 33.5 to 99.8 million rubles for the corresponding period). Thus, the growth of the invested capital was due to the growth of the borrowed capital, being relatively cheaper compared to its own entity (see the growth of financial leverage in Table 1). At the same time, as mentioned above, the dynamics of changes in profitability and liquidity was quite positive.

The growth of cash flows in 2017 led to a noticeable improvement in the value indicators of JSC "Novosibirsk instrument engineering plant" and, consequently, to the conclusions about the business efficiency growth – Tobin rate exceeded the 100% milestone more than twice times.

This calculation showed that with an increase in liquidity and profitability, on the contrary, enterprise value fell down, which, according to the theory of corporate financial management, means ineffective management of the enterprise.

Tables 2 and 3 present calculations of enterprise value for LLC "Production company Aquarius" and JSC "Elatomsky instrument plant" respectively.

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[5] Tobin's rate is calculated as the ratio of the fundamental value to the book company value and generally characterizes the level of the company's performance for shareholders (the value of Q<100% means loss of capital by shareholders).

[6] A correction was made to provision of a company with required working capital.

[7] equal to the ratio of Debt to Equity

[8] equal to the sum of Debt and Equity

Table 2. Value indicators for the company under study. LLC "Production company Aquarius".

Indicator	Index	Valuation date 31.12.2017
Weighted Average Cost of Capital, %	WACC	24.6
Fundamental Value of company, thousand rubles	V	2,087,609.6
Tobin rate, %	Q	380.8
Free Cash Flow to Firm (total cash flow to investors for the three years preceding the valuation date), thousand rubles	FCFF	294,378.8
Equity, thousand rubles	E	548,210.0
Debt, thousand rubles	D	0
Financial Leverage, units	FL	0
Invested Capital, thousand rubles	IC	548,210.0

Source: compiled by the authors on the materials obtained.

Table 3. Value indicators for the company under study. JSC "Elatomsky instrument plant".

Indicator	Index	Valuation date 31.12.2017
Weighted Average Cost of Capital, %	WACC	43.9
Fundamental Value of the company, thousand rubles	V	831,931.2
Tobin rate, %	Q	50.5
Free Cash Flow to Firm (total cash flow to investors for the three years preceding the valuation date), thousand rubles	FCFF	1,096,733.0
Equity, thousand rubles	E	1,648,894.0
Debt, thousand rubles	D	0.0
Financial Leverage, units	FL	0.0
Invested Capital, thousand rubles	IC	1,648,894.0

Source: compiled by the author on the materials obtained.

These calculations led to the conclusion that the traditional indicators of financial and economic analysis do not allow to fully evaluate a company's performance.

The direct impact of cash flows on the enterprise value, in its turn, goes in two directions:

- through the cash flow value factor over the forecast years;
- through the cash flow structure factor over the forecast years.

The determination of the influence of the particular indicators' factor and the structural factor on the resultant indicator is carried out within the methodology of deterministic factor analysis by means of structural shifts, taking into account the deviation from the average value, presented by A.Ya. Vaninsky [18].

In relation to the enterprise valuation, the problem was being solved in [19]. This technique allowed the authors to develop an algorithm for identifying the influence of cash flow factors on the enterprise value, which can be represented in the form of the following successive stages:

1. Total cash flow is calculated for the years of the forecast period of *n* years and the first year of the post-forecast period (formula 6):

$$FCFF_{\Sigma} = \sum_{i=1}^{n+1} FCFF_i \tag{6}$$

2. The share ratio of the cash flow structure is calculated for the years of the forecast period and the first year of the post-forecast period (formula 7):

$$k_i = \frac{FCFF_i}{FCFF_{\Sigma}} \tag{7}$$

where $i=1,2,...,(n+1)$.

3. The total discounted cash flow is calculated for years of the forecast period and the first year of the post-forecast period (formula 8):

$$FCFF_{i\Sigma} = \begin{cases} \dfrac{FCFF_{\Sigma}}{(1+DR)^i}, & if \quad i=1,2,...,n \\[3mm] \dfrac{FCFF_{\Sigma}}{(DR-t)\cdot(1+DR)^{i-1}} & if \quad i=n+1 \end{cases} \tag{8}$$

where $i=1,2,...,(n+1)$.

4. The basic values of the cash flow structure coefficients are obtained from the the system of linear equations presented in the matrix record (formula 9):

$$A\cdot k = B \tag{9}$$

where

$$A = \left\{ a_{ij} \right\}$$ - matrix of equation coefficients (see formula 10);

$$a_{ij} = \begin{cases} 0, & if \quad i<n+1 \quad and \quad (j<i \quad or \quad j>i+1) \\[3mm] -\dfrac{k_i}{(1+DR)^i}, & if \quad i=j \quad and \quad i<n+1 \\[3mm] \dfrac{k_{i+1}}{(1+DR)^{i+1}}, & if \quad j=i+1 \quad and \quad i<n+1 \\[3mm] 1, & if \quad i=n+1 \end{cases} \tag{10}$$

$$k = \left\{ k_i^{(0)} \right\}$$ - column vector of basic cash flow structure coefficients;

$$B = \left\{ b_i \right\}$$ - column vector of the right-hand sides of the linear equation system (see formula 11);

$$b_i = \begin{cases} \dfrac{DA}{FCFF_{\Sigma}^{(0)}}, & if \quad i<n+1 \\[3mm] 1, & if \quad i=n+1 \end{cases} \tag{11}$$

where *DA* - amount of annual depreciation.

5. The effect of the cash flow structure factor is calculated (formula 12):

$$\Delta RV^{k_i} = \sum_{i=1}^{n+1}(k_i^{(1)} - k_i^{(0)}) \cdot (FCFF_{i\Sigma}^{(0)} - RV^{(0)}) \tag{12}$$

6. The effect of total cash flow factor is calculated (formula 13):

$$\Delta RV^{FCFF_{i\Sigma}} = \sum_{i=1}^{n+1}k_i^{(1)} \cdot (FCFF_{i\Sigma}^{(1)} - FCFF_{i\Sigma}^{(0)}) \tag{13}$$

The developed models provide an opportunity to identify value of the factors that determine the subsequent change in the enterprise value. We consider the possibility of a numerical study of these factors as a necessary prospect for the research in the following stage.

5. Conclusion

The results obtained prove that the goals of the research have been achieved.

1. The model for calculation of free cash flow to firm index is presented. This model allows carrying out forecast calculations and reasonably forming a financial model for enterprise valuation.

2. The economic mathematical model for calculating the weighted average cost of invested capital is worked out.

3. Testing of the developed models on three sample companies made it possible to assess effectiveness and substantiate the hypothesis of the necessity to use company value analysis for interpreting economic and financial performance of Russian companies.

4. The developed models of cash flow factor analysis allow automating companies' valuation in the future and reducing the complexity of economic justification for management decisions related to investments in the company's growth.

In general, we have confirmed the hypothesis that the traditional indicators of financial and economic analysis do not allow to fully evaluate the company. Managing the companies' finance, it is necessary to affect the specific factors influencing the cash flows which have been identified in the study. Thus, the highest goal of corporate financial management, the growth of the company value, will be achieved.

The current research opens potential for further investigation in working out mechanisms of influence on the company cash flows in value-based management.

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