BEAVER'S TECHNIQUE OF RISK ASSESSMENT IN THE ESTIMATION OF THE FINANCIAL POSITIONS OF COMPANIES

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Proposed technique of α_i rate estimation of Beaver's coefficient k_i in the portfolio, formed by these coefficients, allows us to minimize the average squared error estimation of portfolio efficiency. This technique allows an expert to get additional information about credit solvency of the experimental company.

Keywords: solvency, bankruptcy, portfolio, random quantity, risk of error, portfolio efficiency, measures of risk, quadratic programming

One of the indicators, characterizing the financial condition of the company, is its solvency, i.e. the ability to repay liabilities in time.

The necessity of implementation of borrower liability analysis is dictated by the lending policy and concerns of bank. The bank needs to be informed: will the borrower be able to pay back cash resources with a glance at interests fixed by the bank, does the bank have prospects for future development, and how high is the risk of not recouping the fixed sums?

The basic attention by borrower's solvency estimation is concentrated on the activity, characterizing his ability to provide quickly his quick credit and interests' repayment.

For bankruptcy forecast of a company financial analyst Williams Beaver offered a system of indicators, letting estimate the financial condition of a company to diagnose bankruptcy [1].

Target setting

The quantity of the existing bankruptcy threat of the company we can estimate (in the rough) by pentad model of *W*. Beaver based on calculation of company activities: a_1 – net profit, a_2 – depreciation of production assets, a_3 – loan capital, a_4 – working assets, a_5 – current liabilities to juridical entities and individuals, a_6 – internal circulating funds, a_7 – noncirculating assets.

The rates a_i, $i = 1, ..., 7$, let calculate the value of the coefficients:

$$k_1 = \frac{(a_1 + a_2)}{a_3};\quad k_2 = \frac{a_4}{a_5};\quad k_3 = \frac{a_1}{(a_4 + a_7)};$$

$$k_4 = \frac{a_2}{(a_4 + a_7)};\quad k_5 = \frac{a_6}{(a_4 + a_7)}. \qquad (1)$$

On the basis of the values k_i, $i = 1, ..., 5$, valued by *W*. Beaver for three types of companies: successful, bankrupt during a year and bankrupt during five years, we can make a conclusion about the bankruptcy risk of the experimental company. System of values and regulatory indicators for these three types of companies is presented in the Table 1 [2].

Table 1

Metrics of W. Beaver

Coefficient k_i	Coefficient value k_i	Standard values of calculated coefficients and quantities		
		Group 1, successful companies	Group2, 5 years before bankruptcy	Group 3, 1 year before bankruptcy
Coefficient of beaver, k_1	$k_1 = \frac{(a_1 + a_2)}{a_3};$	$k_1 > 0,4$	$k_1 \approx 0,2$	$k_1 < -0,15$
Coefficient of current liquidity, k_2	$k_2 = \frac{a_4}{a_5};$	$k_2 > 2$	$1 \le k_2 \le 2$	$k_2 < 1$
Return of assets, k_3	$k_3 = \frac{a_1}{(a_4 + a_7)};$	$k_3 \ge 0,06$	$0,01 \le k_2 \le 0,06$	$-0,22 \le k_2 \le 0,01$
Coefficient of financial dependence, k_4	$k_4 = \frac{a_2}{(a_4 + a_7)};$	$k_4 < 0,35$	$0,35 \le k_4 \le 0,80$	$k_4 \ge 0,80$
Share of own circulating funds in the assets, k_5	$k_5 = \frac{a_6}{(a_4 + a_7)}.$	$k_5 \ge 0,4$	$0,1 \le k_5 \le 0,4$	$k_5 < 0,1$

We will form a 'portfolio' from coefficients k_i, i.e. we will form sum total (k_1, ..., k_5) from Beaver's rates. Let α_i – be share of coefficient k_i in total (k_1, ..., k_5) (i.e. α_i – weight or coefficient of value k_i), $\alpha_i \geq 0$, $i = 1, ..., 5$, $\alpha_1 + ... + \alpha_5 = 1$. We'll suppose that k_1, ..., k_5 are random quantities. Let σ_i – be the root-mean-square deviation k_i, $R = \alpha_1 k_1 + ... + \alpha_5 k_5$ –efficiency of sum total (k_1, ..., k_5) (R – sum points of all the rates of this totality).

The aim of this project – to work out the technique of shares estimation coefficients k_i, $i = 1, ..., 5$,, in the portfolio, when the risk lets make mean-square error in the portfolio efficiency estimation, i.e. when by estimation R is minimum.

This technique allows an expert receive to additional information about credit solvency of the company.

The results of investigation offered in this project are logical continuation of investigations, the results of which are stated in works [3, 4].

The technique of portfolio optimization from Beaver's values

According to suppositions from point 1 risk level to make mean-squared error evaluating credit solvency of the company is [5, 6]:

$$\sigma^2 = D[R] = \nu_p = \sum_{i=1}^{5}\sum_{j=1}^{5} \alpha_i \alpha_j \nu_{ij} \quad (2)$$

where v_{ij} – covariance between k_i, k_j, i.e. $v_{ij} = \text{cov}(k_i, k_j)$, $i, j = 1, ..., 5$.

The task of share defining α_i, $i = 1, ..., 5$, of different Beaver's values is brought to task solution of portfolio optimization:

$$\begin{cases} \sum_{ij=1}^{n} \alpha_i \alpha_j v_{ij} \to \min, \quad v_{ij} = \text{cov}(k_i, k_j); \\ \sum_{i}^{n} \alpha_i = 1; \\ \alpha_i \geq 0, ..., \alpha_n \geq 0; \\ i = 1, \cdots, 5. \end{cases} \quad (3)$$

This task represents the task of minimizing of quadratic form from n variables α_1, ..., α_n, meeting the conditions $\sum_{i=1}^{n} \alpha_i = 1$, $\alpha_i \geq 0$, $i = 1$, ..., 5, i.e. the task of quadratic programming.

The solution of this task can be built with the usage of different instruments, for example, using software environment Excel.

Solving the equation (3), we'll get different values of α_i^*, $i = 1, ..., 5$. The more value α_i^*, the more influence has the indicator i of k_i on the risk level, i.e. lets allow mean-squared error evaluating the efficiency of portfolio totality from Beaver's rates.

Example

Experimental data of Beaver's rates (see Table 1), calculated on the basis of balance sheet of the company, public corporation 'Lenmoloko' [7], presented in the Table 2.

Table 2

Beaver's values of public corporation «Lenmoloko»

Value	Values numbers				
	On 12/31 2011	On 12/ 31 2010	On 12/ 31 2009	On 12/31 2008	On 12/31 / 2007
Beaver's coefficient, k_1	2,186	1,271	0,432	0,315	0,653
Coefficient of current liquidity, k_2	0,238	0,551	2,967	2,486	2,054
Efficiency of assets, k_3	0,902	0,697	0,127	0,112	0,241
coefficient of financial dependence, k_4	0,413	0,549	0,294	0,357	0,369
Share of own circulating funds in the assets, k_5	–0,314	–0,246	0,579	0,531	0,389

We'll calculate arithmetic mean of Beaver's i indicator using the formula:

$$\overline{k_i} \approx \frac{1}{N} \sum_{i=1}^{N} k_i. \quad (4)$$

Using the data of Table 2 and formula (4) we'll find that $\overline{k_1} \approx 0,971$, $\overline{k_2} \approx 1,659$, $\overline{k_3} \approx 0,416$, $\overline{k_4} \approx 0,396$ and $\overline{k_5} \approx 0,188$.

The elements V_{ij} of covariance matrix V of indicators k_i, we'll calculate by the formula:

$$V_{ij} = \frac{1}{N}\left\{\overbrace{(k_i - \bar{k}_i)}^{\Delta_i}\cdot\overbrace{(k_j - \bar{k}_j)}^{\Delta_j}\right\} \approx \frac{1}{N}\sum_{i=1}^{N}\Delta_i \cdot \Delta_j. \qquad (5)$$

We'll have:

$$V = \{V_{ij}\} = \begin{pmatrix} V_{11} & V_{12} & V_{13} & V_{14} & V_{15} \\ V_{21} & V_{22} & V_{23} & V_{24} & V_{25} \\ V_{31} & V_{32} & V_{33} & V_{34} & V_{35} \\ V_{41} & V_{42} & V_{43} & V_{44} & V_{45} \\ V_{51} & V_{52} & V_{53} & V_{54} & V_{55} \end{pmatrix} = \begin{pmatrix} 0{,}478 & -0{,}686 & 0{,}217 & 0{,}031 & -0{,}248 \\ -0{,}686 & 1{,}159 & -0{,}340 & -0{,}074 & 0{,}341 \\ 0{,}217 & -0{,}340 & 0{,}104 & 0{,}019 & -0{,}096 \\ 0{,}031 & -0{,}074 & 0{,}019 & 0{,}007 & -0{,}027 \\ -0{,}248 & 0{,}341 & -0{,}096 & -0{,}027 & 0{,}150 \end{pmatrix} \qquad (6)$$

Solving the task (3) with the usage of the program environment Microsoft Excel, we'll find α_i^*, $i = 1, ..., 5$:

$$\begin{pmatrix} \alpha_1^* \\ \alpha_2^* \\ \alpha_3^* \\ \alpha_4^* \\ \alpha_5^* \end{pmatrix} = \begin{pmatrix} 0{,}019 \\ 0{,}026 \\ 0{,}032. \\ 0{,}824 \\ 0{,}098 \end{pmatrix} \qquad (7)$$

Minimum variance (minimum rate of error risk) is equal:

$$\sigma^2 = D[R] = 0{,}0011952.$$

From these calculations we can make a conclusion that by evaluation of mean-squared error of R, k_4 is more significant in comparison with k_1, k_2, k_3 and k_5, α_1^*, α_2^*, α_3^* and α_5^* is much less than α_4^*, that is k_4 has more influence on risk level.

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