





where  $M_i$  is a dichotomous variable taking the value 1 for companies frauding on accounts;

$X_i$  is a vector of explicative variables;

$\tilde{\varepsilon}$  is a vector of errors.

In his research, M. Beneish evaluated 2.400 American companies and found a relationship between the probability of financial statement fraud and a number of financial indicators of the enterprise.

The result of the investigation was the composite index of the risk valuation of financial statement fraud – M-score:

$$M\text{-score} = -4.84 + 0.920 \times DSRI + 0.528 \times GMI + 0.404 \times AQI + 0.892 \times SGI + 0.115 \times DEPI - 0.172 \times SGAI + 4.679 \times TATA - 0.327 \times LVGI \quad (2)$$

where: DSRI is Days Sales in Receivables Index;

GMI is Gross Margin Index;

AQI is Asset Quality Index;

SGI is Sales Growth Index;

DEPI is Depreciation Index;

SGAI is Sales General and Administrative Expenses Index;

LVGI is Leverage Index;

TATA is Total Accruals to Total Assets.

Investigating the financial statements data of companies from the United States, Beneish determined the boundaries of the financial indicators used in the model, exceeding which increases the probability of misrepresentation of the presented financial statements. Based on them, the threshold value of the M-score composite index was determined for organizations that did not perform creative accounting with 2.2.

the value of M-score  $\leq -2.2$  – the presence of misstatement is unlikely;

M-score value  $\geq -2.2$  – possible misstatement.

The Beneish model was tested and verified by Maria L. Roxas in 2011, using the example of American companies as well [3].

After analyzing the indicators used by Beneish, Roxas declined to include Sales General and Administrative Expenses Index (SGAI), Leverage Index (LVGI), and Total Accruals to Total Assets (TATA) as having an insignificant impact. As a result, we get a new term of the m-score indicator, limited to five indicators and recalculated thresholds:

$$M\text{-score} = -6.065 + 0.823 \times DSRI + 0.906 \times GMI + 0.593 \times AQI + 0.717 \times SGI + 0.107 \times DEPI \quad (3)$$

Roxas also recalculated the threshold value of the m-score composite index for organizations that did not perform creative accounting, which was 2.76.

- M-score value  $\leq -2.76$  – misstatement is unlikely;

- the value of M-score  $\geq -2.76$  – possible presence of misstatements.

Thus, the Beneish and Roxas models are efficient modern tools for detecting misrepresentations in companies' financial statements. However, they are based on the data of companies represented in the US market, and are only valid for similar businesses due to differences in the methods of accounting and reporting.

The applicability of Beneish and Roxas models for detecting fraud statements in companies keeping records in accordance with Russian accounting standards was studied by N. V. Feruleva and M. A. Stefan [4]. The M-score composite index developed by Beneish

was upgraded by excluding Depreciation Indexes (DEPI) and Total Accruals to Total Assets (TATA), and boundary values were set to adapt the model to Russian conditions (Table 1).

**Table 1.** Boundary values of financial indicators [4]

Value	Indicator					
	DSRI	GMI	AQI	SGI	SGAI	LVGI
According to Russian companies	1.408	1.260	1.186	1.280	1.025	1.119
According to the American companies	1.031	1.014	1.039	1.134	1.000	1.000

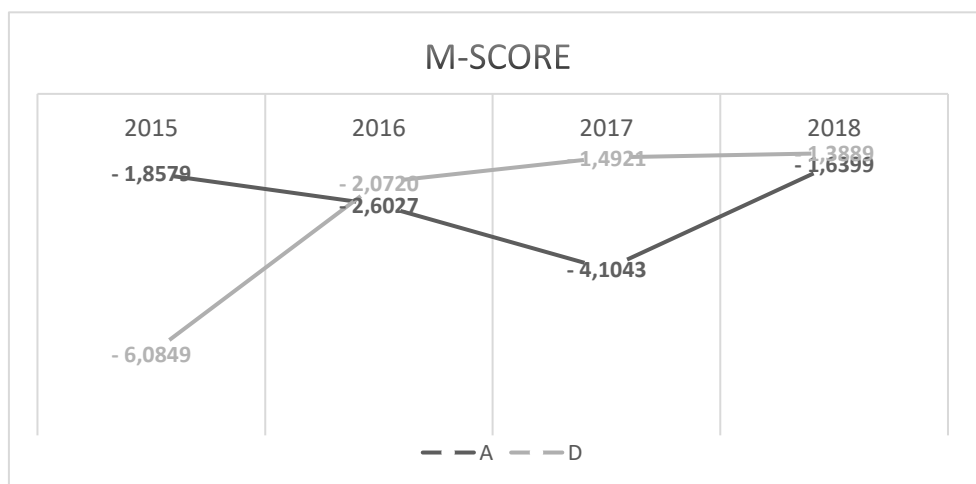
Taking into account the changed boundary values of financial indicators for Russian companies, the thresholds of the composite index were also recalculated:

- M-score Beneish – -1.802;
- M-score Roxas – -2.146.

Based on these models, the authors of the study evaluated the reporting on the probability of its distortion of leading Russian companies from various sectors of the economy. In Table 2 the results of calculating the M-score composite index are presented [7].

**Table 2.** Composite index (Beneish model) for Russian companies [7]

Company	M-score (Beneish model)			
	2015	2016	2017	2018
A	-1.8579	-2.6027	-4.1043	-1.6399
B	-2.6781	-1.8862	-1.9219	-2.0380
C	-2.1484	-2.2590	-2.7102	-3.0619
D	-6.0849	-2.0720	-1.4921	-1.3889
E	-2.6143	-2.1564	-2.2925	-2.4237
F	-3.1723	-2.0926	-1.9062	-2.6539
G	-2.6530	-2.5954	-2.1708	-2.2314



**Fig. 1.** Diagram of changes in M-score indicators (Beneish model)

When analyzing the results (Table 2), it can be seen that only two companies exceed the threshold value of the composite index: A and D.

For company A (Table 3), these changes in 2018 are due to a sharp decrease in the company's revenue for 2017 by 52% compared to this indicator in 2016. In the 2018 report, the company again showed revenue growth of 85% from the 2016 level. Excluding this factor, the dynamics of the company's indicators shows a steady decrease in the relative threshold value (Figure 1).

In turn, company D 2017-2018 was in an active investment phase, raising funds, as a result of which the company's accounts receivable and balance sheet increased by more than 30% in 2018, which affected the daily sales indices in accounts receivable and asset quality (Table 4).

**Table 3.** Coefficient values of A company for the Beneish model [7]

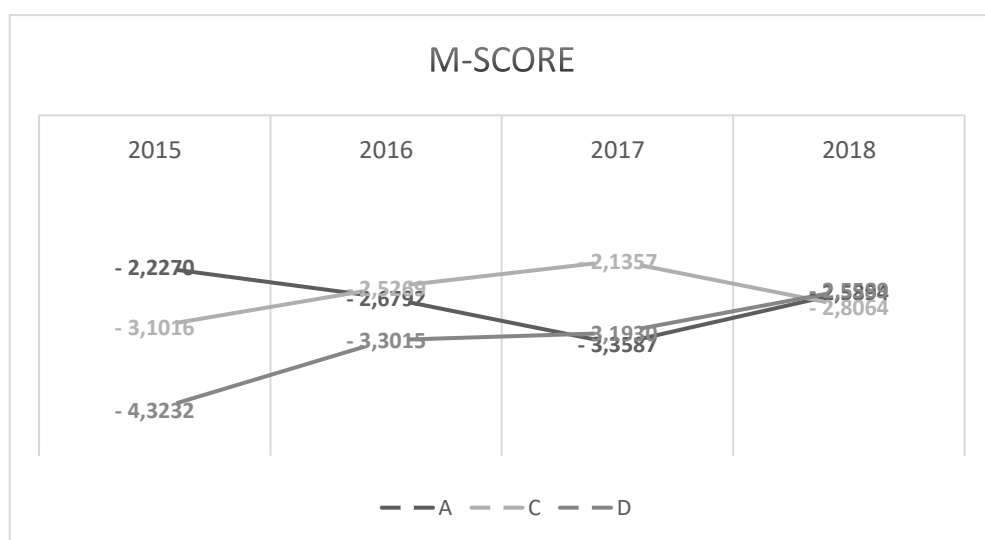
	Name of the indicator	Symbol	2015	2016	2017	2018
1	Days Sales in Receipts Index	DSRI	2.5216	0.9968	0.9392	0.7329
2	Gross Margin Index	GMI	0.8614	1.0136	0.9582	1.1191
3	Asset Quality Index	AQI	0.9035	1.1648	0.9977	0.9764
4	Sales Growth Index	SGI	0.5179	1.1888	0.5208	1.6335
5	Depreciation Index	DEPI	0.7034	0.9729	0.9364	1.0116
6	Sales General and Administrative Expenses Index	SGAI	2.2638	0.9460	1.1834	0.6058
7	Leverage Index	LVGI	1.3124	1.2194	1.4585	1.1214
8	Total Accruals to Total Assets	TATA	0.0252	-0.0633	-0.1986	0.0936
9	M-score (Beneish model)		-1.8579	-2.6027	-4.1043	-1.6399
10	M-score (Roxas model)		-2.2270	-2.6792	-3.3587	-2.5894

**Table 4.** Coefficient values of D company for the Beneish model [7]

	Name of the indicator	Symbol	2015	2016	2017	2018
1	Days Sales in Receipts Index	DSRI	1.6489	0.8888	0.6041	1.5437
2	Gross Margin Index	GMI	1.0006	1.0193	0.9918	1.0056
3	Asset Quality Index	AQI	-2.7461	0.1170	0.9031	0.6473
4	Sales Growth Index	SGI	1.3677	1.3623	1.1908	1.1408
5	Depreciation Index	DEPI	1.1784	0.5827	0.8122	1.1469
6	Sales General and Administrative Expenses Index	SGAI	0.9320	0.8914	1.0172	0.9672
7	Leverage Index	LVGI	1.0708	1.2186	0.8009	0.8317
8	Total Accruals to Total Assets	TATA	-0.6467	0.1356	0.2532	0.1127
9	M-score (Beneish model)		-6.0849	-2.0720	-1.4921	-1.3889
10	M-score (Roxas model)		-4.3232	-3.3015	-3.1930	-2.5589

**Table 5.** Composite index (Roxas model) for Russian companies (Compiled by the author in tables 2-4)

Company	M-score (Roxas model)			
	2015	2016	2017	2018
A	-2.2270	-2.6792	-3.3587	-2.5894
B	-2.9457	-2.6069	-2.6191	-2.7156
C	-3.1016	-2.5269	-2.1357	-2.8064
D	-4.3232	-3.3015	-3.1930	-2.5589
E	-2.7981	-2.7004	-2.7461	-2.7968
F	-2.7581	-2.9144	-2.9232	-2.7463
G	-2.7791	-2.7278	-2.8507	-2.8200



**Fig. 2.** Diagram of changes in M-score indicators (Roxas model)

Analysis of the financial statements of enterprises by the Roxas model showed that the composite index of the indicator of companies is below the boundary value. The only exception was enterprise C, which slightly exceeded its value in 2017. The final indicator was also affected, as in the previous example, by a change in the asset quality index caused by a decrease in current assets while increasing non-current assets at the same value of the balance sheet currency.

In turn, companies A and D, which results exceeded the threshold value when calculating the indicator using the Beneish model, showed the value of the composite index within the acceptable range. It is worth noting that company D's composite index steadily increases over the entire period under review, approaching the boundary value (Figure 2).

The analysis of the applicability of the Beneish and Roxas model for detecting financial statement fraud, taking into account the boundary values calculated for Russian companies by researchers N. V. Feruleva and M. A. Stefan, proved its validity.

A special feature of the study was that these models were used to analyze the accounting of large Russian public joint-stock companies, whose stock indices form the composite indices of MICEX and RTS. Thus, the quality of information provided in their financial documentation directly affects the image of the Russian stock market by investors.

The accounting of these companies includes a positive audit value, which also confirms the absence of fraud and misstatements proved in this study.

### 3 Conclusion

Due to the peculiarities of accounting, the Roxas model with the boundaries of indicators applicable to Russian companies is more preferable, since it excludes indexes that do not affect the final result, which simplifies the calculation and reduces probable errors.

These methods of evaluating companies' financial statements allow obtaining a comprehensive and rapid assessment of the financial condition of an enterprise based on public sources, but the results of calculations should be used as an additional factor confirming either the probability of misstatements or their absence, and being a prerequisite for additional verification if necessary. To make an unambiguous conclusion about the existence of facts of financial statement fraud, it is necessary to carry out a deeper analysis of the company, external and internal factors that affect changes in indicators, the stage of development of the company, as well as the state of the industry as a whole.

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