Binary Choice Models-based Assessment of Company's Financial Sustainability

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Abstract. Assessment of financial sustainability is a key instrument that every company should use to successfully operate in the contemporary marketplace. In this paper profit was chosen as one of the sustainability indices and binary choice model - logistics regression model (logit model) was built for that index. The research data for this study is drawn from accounting statements of a textile industry business in Samara city. A combination of econometric approaches was used in the data analysis. Binary choice models were adopted in this research. Then those models were estimated for validity. Also scenario forecasts methodology was employed in this study. Several logit models with a set of explanatory variables were constructed. After the comparison of those models the preferred one was determined. Based on that model a scenario for profits was forecasted including both the worst-case and the best-case ones. The average-case scenario forecast was also made.

Keywords: financial sustainability, forecasting, logit model, profit.

1 Introduction

An effective assessment of the financial sustainability of a particular company alongside with the identification of adverse trends in its development, and bankruptcy forecasting is a prerequisite for ensuring the sustainable development of the Russian economy. Although, widely varying definitions of financial sustainability have emerged, it is generally understood to characterize the normal financial condition of any business [1].

Currently there are various methods for studying the financial sustainability of a company, which differ in both the system of indicators and the research methods [2, 3], including econometric ones.

2 Problem Statement

If a company does not have a stable positive financial gain (profit), and in some periods works at a loss, then modeling and forecasting the financial results of its activities based on traditional econometric methods (building a multifactor linear regression model, various autoregressive models, etc.) [4, 5] may be not quite correct because of the strong variation of the dependent variable values. In this case, the binary choice models should be used, including the logit model [6]. That could allow finding the answer to the question: what financial result can be expected with a specific set of factor indices?

In modern economic research binary choice models and logit models in particular are used to solve various economic problems. These models are widely used in scoring systems, when a bank assesses the borrower's creditworthiness [7], when the probability of the bank license revocation is analyzed [8], when liquidation factors of enterprises are studied [9]. In work [10], both logit models and probit and tobit models were applied in the studies of the effectiveness of stimulating investment methods in the timber industry complex. Quite often binary choice models are used to predict bankruptcy in various industries, for example, in the hotel business [11], to better explain and forecast the sources of financial difficulties of a firm [12], to assess bank risk [13], or to study foreign direct investment in enterprises [14].

The logit model was used in this paper to study the financial sustainability of a company. Profit was modeled and forecasted as an indicator of financial sustainability.

The study is based on the data from financial statements of one of the textile industry companies of Samara. The following financial indices were used:

Y - monthly profit (thousand rubles),
X_1 - production costs (thousand rubles),
X_2 - general and administrative expenses (thousand rubles),
X_3 - revenue (thousand rubles).

The information array of the study represents the time series in monthly dynamics for the period from January 2016 to June 2018. The programs MS Excel, Gretl и Eviews were used to carry out calculations.

3. Research Questions

This research set out to determine the best econometric model for assessing financial sustainability of the company under study. This research also seeks to examine the expected financial result of the company's operations under the specific set of factor indices.

4. Purpose of the Study

Thus, the first objective of this research is to generate the model of profit as a financial sustainability index. Another aim is to assess and forecast three scenarios for expected profit using the constructed model. The worst-case, the best-case and the average-case scenario will be included in the forecast.

5. Research Methods

In this study a combination of econometric methods was used for profit modeling and forecasting. The approach to empirical research adopted for this study included construction of binary choice models, assessment the validity of these models, and scenario forecasting.

6. Findings

Figure 1 demonstrates time series graph for Y index (monthly profit). The dynamics of the time series for this index is unstable. There are significant fluctuations in the levels of the series and negative values are present in the graph.

When building a logit model, the dependent variable Y was converted to a binary variable D as follows: $D_i = 0$ if the company operated at a loss in the i-th month, and $D_i = 1$ if the company received profit in the i-th month, i.e.

$$D_i = \begin{cases} 0, \text{ if } Y_i \le 0 \\ 1, \text{ if } Y_i > 0 \end{cases}.$$

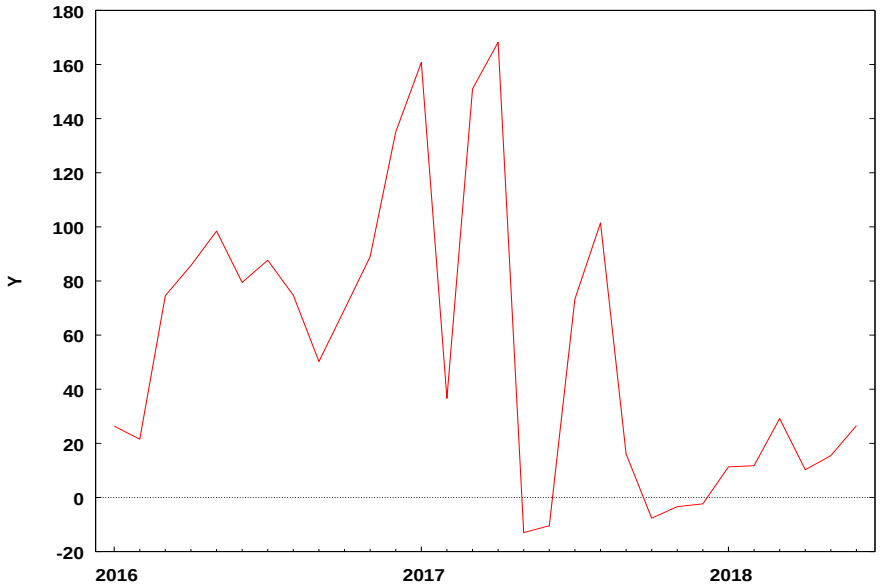

Figure 1. Dynamics of monthly profit (Y, thousand rubles) from January 2016 to June 2018 (Source: compiled by the authors)

Logit models were constructed with a different set of explanatory variables: (X_1, X_2, X_3), (X_1, X_2), (X_1, X_3), (X_2, X_3). To estimate the parameters of the logit model, the maximum likelihood method was used, which was represented in the Gretl program. Table 1 presents the characteristics reflecting the quality of the constructed models. When comparing all constructed logit models, the model with a set of explanatory variables (X_1, X_2, X_3) was chosen based on its quality.

Table 1. Quality characteristics of the constructed logit models

Explanatory variables	Akaike criterion value	Schwarz criterion value	McFadden's R^2	Correct forecasts number
X_1, X_2, X_3	21.53	23.33	0.426	93.3%
X_1, X_2	29.06	30.40	0.147	86.7%
X_1, X_3	28.53	29.87	0.052	86.7%
X_2, X_3	24.69	26.03	0.207	90.0%

Source: compiled by the authors.

Thus, the probability of the company receiving profit is determined by the following logit model:

$$P(D=1) = F(Z) = \frac{e^z}{1+e^z}, \quad (1)$$

where $Z = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3$.

After estimating the parameters, the following equation was obtained (standard errors of the corresponding coefficients are presented in parentheses):

$$\hat{Z} = \underset{(2.06)}{-5.29} - \underset{(0.02)}{0.08} X_1 - \underset{(0.03)}{0.10} X_2 + \underset{(0.02)}{0.09} X_3. \quad (2)$$

Then model (1) is as follows:

$$P(D=1) = \frac{e^{-5.29-0.08X_1-0.10X_2+0.09X_3}}{1+e^{-5.29-0.08X_1-0.10X_2+0.09X_3}}. \quad (3)$$

The table containing the number of errors based on the modeling was generated to check the validity of the constructed logit model (Table 2).

Table 2. Classification table

Observed	Forecasted "profit"	Forecasted "loss"	% correct classification
"profit"	26	0	100
"loss"	2	2	50

Source: compiled by the authors.

The constructed model forecasts 26 of the 26 cases of profit gain for the company, which is 100% correct predictions, and 2 of 4 cases of losses, i.e. 50% correct predictions. Thus, the number of "correctly forecasted" cases was 28, i.e. 93.3%.

The constructed logit model can be considered valid. All parameter estimates are statistically significant at the level of 0.05, the total losses estimated by the maximum likelihood function are small (the observed value is $\chi^2 = 10.04$ with p-value equal to 0.0183).

It should be noted that in the binary choice models only the signs of parameter estimates [15] could be interpreted. In this case, with an increase in the cost of production (X_1) and administrative and management expenses (X_2), the probability of making a profit decreases, and with an increase in revenue (X_3), it increases.

To predict the financial performance of the company with the logit model, various values of cost price (X_1), administrative and management expenses (X_2) and revenues (X_3) were substituted into the equation (3). The resulting value of the probability shows the possible financial result (profit or loss) under the given conditions.

Three scenarios were considered:

1. Worst-case scenario (maximum cost and administrative expenses with minimum revenue). In this case, the expected financial result is a loss (the probability of receiving a profit $P = 0$).

2. Average-case scenario (with average costs, administrative expenses and revenues). The expected financial result is profit ($P = 0.9495$).

3. Best-case scenario (minimum cost and administrative expenses with maximum revenue). The expected financial result is profit ($P = 1$).

Thus, the constructed model confirms the need to reduce the production costs and to cut administrative and management costs to improve the financial stability of the company under study.

7. Conclusion

The following financial indices were selected to study the financial sustainability of the company: monthly profit, product cost, administrative and management expenses, and revenue. The profit was considered as the financial result of the company's activity. For its modeling the binary choice model - a logistic regression model (logit model) was used.

Among the constructed models with a different set of explanatory variables, a logit model was chosen with a set of explanatory variables (X_1, X_2, X_3). The analysis revealed that the model parameter estimates are statistically significant at a significance level of 0.05. The findings from this study suggest that the total loss estimated by the maximum likelihood function is small.

Using the constructed logit model, the scenario forecast was made in accordance with the worst-case, the best-case and the average-case scenarios.

It was concluded that the proposed research method can be used to simulate the profits of companies with low information reporting capacity to identify profit growth reserves and analyze the financial sustainability and investment attractiveness of the company.

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