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**EMPIRICAL RESULTS OF TESTING
THE ALTMAN MODELS (BANK SECTORS)**

Abstract. An analysis of this study shows that the classification accuracy can be significantly improved with a country-specific assessment, especially with the use of additional variables. In some country models, the information provided by the additional variables helps to raise the classification accuracy to a higher level. The first multidimensional bankruptcy prediction model was developed by E.I. Altman (1968) from New York. Following this groundbreaking work, a multivariate approach to predicting disruptions has spread around the world to researchers in finance, banking, and credit risk. Failure forecasting models are important tools for bankers, investors, asset managers, rating agencies, and even problem firms themselves. The banking sector as the main provider of financing in the economy is especially interested in minimizing the level of non-performing loans in order to maximize profit from lending activities and reduce their own default risk.

Keywords: credit risks, empirical research, result, model, banking sector.

INTRODUCTION

Empirical and research methods theoretical search there are the following groups of research methods:

Empirical, under which the externally real interaction of the subject and the object of study.

The basis of empirical methods is sensory knowledge (sensation, perception, presentation) and instrument data.

General classification of empirical methods:

- Observation;
- Experiment;
- Chatting;
- Poll;
- Questioning.

Study the process of products activities:

- Testing;
- Evaluation.

There are no pure empirical methods in scientific knowledge, since even for simple observation, preliminary theoretical grounds - the choice of object for observation, hypothesis formulation etc.

General scientific empirical methods include observation, experiment, measurement.

Observation is often the only method for a number of natural sciences (a classic example is astronomy, where all research is conducted using this method, and discoveries are made based on the improvement of surveillance technology).

The empirical stage consists of 2 steps (stages) of work:

- the first stage is the process of obtaining, obtaining and fixing facts;
- The second stage is the primary processing and evaluation of the facts in their relationship, that is, it includes:

- understanding and strict description of extracted facts in terms of scientific language;
- classification of facts and identification of main dependencies between them.

During this phase, the researcher performs:

o critical assessment and verification of each fact, clearing it from random and non-essential parts; o description of each fact in scientific language.

Today, it is necessary to change the outlook of domestic scientific and practical circles in relation to credit risk management in general, as well as its assessment and regulation. Credit risk management is able to create added value for the banking business for its founders, as well as provide the bank with additional stability and competitive advantages in the market.

MAIN PART

In modern conditions, the growth rate of lending to the real sector of the economy is accompanied by fierce competition for the client, which forces banks to pursue an aggressive policy of taking excessive risks, including by significantly reducing lending rates, as well as providing super-large loans.

In this situation, the cost of mistakes associated with the adoption of wrong economic decisions by the bank is especially high, and issues of effective risk management become more important. At the same time, insufficient theoretical understanding of credit risk, as well as the insignificant experience of Russian banks in its assessment and regulation in the market, lead to the consideration of credit risk management as a secondary activity derivative with respect to the strategy of asset growth and profit. In practice, risk assessment units are often perceived as constraining the development of a bank's business, delaying decision-making. Equally relevant is the problem of insufficient consideration of the results of risk assessment in decision making.

A significant problem is that this will lead commercial banks to the need to adapt the credit rating models of potential borrowers, primarily the default rating models, to the specifics of companies issuing bond loans.

The difficulty of regulating credit risk in practice is largely associated with a significant time lag between the moment of its acceptance (and the beginning of earning income) and the period of its most likely realization, which, as a rule, comes later. Unrealized credit risk, remaining unrecognized, can accumulate for a long time in bank portfolios and lead to a rapid onset of catastrophic consequences. Opportunities for risk management at this point are usually minimal.

The most common model for assessing the risk of a company's default using the multiple discriminant analysis method is the Altman model. In his work "Financial ratios. Discriminant analysis, and the prediction of corporate bankruptcy, he investigated 66 American manufacturing companies from 1946 to 1965 and brought out a Z-discriminant, which allows companies to be classified as bankrupt or not bankrupt. The advantage of multiple discriminant analysis is that it considers the entire profile of the parameters inherent in the firm, as well as their interaction. The discriminant function converts the value of variables into one discriminant score, or Z value, which is then used to classify companies. The function obtained by Altman is as follows:

$$Z = 1,2X_1 + 1,4X_2 + 3,3X_3 + 0,6X_4 + 0,999X_5$$

Where Z is the resulting discriminant value, X1 is the share of net working capital in total assets, X2 is the share of retained earnings in total assets, X3 is the share of profit before interest and taxes in assets, X4 is the ratio of equity to liabilities, X5 share of revenue in total assets. Thus, the variables represent five categories of standard ratios, including liquidity, profitability, leverage, financial sustainability and turnover.

Based on the value of Z-score, Altman concluded that there was a risk of a company default. If the discriminant value $Z > 2.9$, then the company enters the zone of financial stability and the probability of bankruptcy is extremely small. If the resulting value is in the range from 1.8 to 2.9, then it is not possible to accurately determine the company in any group, this is the so-called gray zone. Finally, a company belongs to the group of potential bankrupts if its Z-discriminant value is less than 1.8.

A huge advantage of the Altman model is its high prediction accuracy (up to 70% of correctly predicted defaults over five years).

In this subclass of models, it is also advisable to consider the model of D. Chessser, which is aimed not only at identifying a potential default, but also of any deviations from the contract between the lender

and the borrower. Chesser investigated 74 bank loans, an equal number of which belonged to groups of good and bad borrowers, that is, those who fully and not fully complied with the terms of the contract, respectively. Based on the analysis of financial statements, the author derived the following model.

$$Z_{Chesser} = \frac{1}{1 + e^{-Y}}$$

$$Y = -2,0432 - 5,24X_1 + 0,0053X_2 - 6,6507X_3 + 4,4009X_4 - 0,0791X_5 - 0,122X_6$$

Where X_1 - (Cash + Marketable Securities) / Total Assets, X_2 - Net Sales / (Cash + Marketable Securities), X_3 - Gross Income / Aggregate Assets, X_4 - Total Debt / Total Assets, X_5 - Principal capital / Net assets, X_6 - Working capital / Net sales.

Moreover, if the discriminant value $Z_{Chesser} \geq 0.5$, then the company is referred to as bad borrowers and vice versa. The Altman model assesses the threat of bankruptcy of the company, while the Chesser model aims to identify the risk of any deviation from the initial arrangements of the bank and the borrower, that most of the significant variables in these models are different. These models allow, without much time and computational effort, to analyze a large number of companies and identify problems at an early stage of their occurrence.

Finally, the third type of model based on financial reporting indicators is the binary choice models, logit and probit models, which are based on logistic regression, not linear. The differences are in different distributions of the probability of default and in the types of functional dependence characteristic for the company indicators and the risk of default. Within the framework of these models, at the first stage, important indicators of the creditworthiness of the borrowing company are identified, and at the second stage, the probability of bankruptcy is estimated. Thus, binary choice models imply two types of variables: a combination of independent indicators and a dependent variable indicating which group the borrower should be assigned to.

There are some differences between these models and models based on multiplicative discriminant analysis, for example, from the Altman model. Logit-models suggest obtaining an accurate estimate of the probability of default, which belongs to the interval from 0 to 1. However, as in the models of discriminant analysis, logistic models consider bankruptcy as an event that occurs all at once, and not during a certain time. It is important to remember here that the logistic model is sensitive to multicollinearity, that is, to the presence of a linear relationship between explanatory factors, and the results can be distorted.

So, Altman in his research work showed that the discriminant analysis proposed by him based on financial indicators makes it possible to assess the risk of default more accurately than a model based on neural networks.

The main advantages and disadvantages of the credit risk assessment models described above are summarized in summary table 1.

Table 1 - Advantages and disadvantages of default assessment models

Market-based models	Models based on fundamental indicators			Modern models
	Macroeconomic models	Models based on accounting and financial reporting indicators	Models used by rating agencies	
High predictive power; Availability of information on the market.	Accounting for the cyclical economy; Application in cross-analysis.	Availability of information; High accuracy of the results.	High predictive power; Ease of settlement.	High predictive power; Accounting for non-parametric quantities.
The need to fulfill the hypothesis of market efficiency; The need for a large array of data.	The difficulty of defining cycles; The difficulty of determining the risk of default of a particular borrower.	Analysis of historical data; The possibility of inaccurate reporting.	Rating review is not permanent.	High temporal and physical costs.

According to the results of the analysis of models for assessing the financial stability of companies, the Altman model based on the MDA method and financial reporting indicators was chosen as the base model. The selected model is characterized by high predictive power, and is also attractive due to the availability of information on the financial performance of the analyzed companies. It is often used in research in both Western developed markets and emerging markets in Asia.

Recall that according to the Altman model, the higher the value of the resulting factor, the lower the probability of bankruptcy.

We can argue that the value of the credit risk of issuing companies, calculated using the Altman model, is higher than the corresponding level for companies that have not issued bonds. Thus, the first hypothesis is confirmed.

Table 2 - Descriptive Variable Statistics

	The average	SKO	Minimum	Maximum
X_1	0.147635828	0.144176101	-0.348446567	0.639274294
X_2	0.117852828	0.653566039	-6.016205016	1.612845732
X_3	0.091206011	0.084531972	-0.26560057	0.43921012
X_4	0.516731903	0.493546697	-0.571806294	3.404594468
X_5	1.112915585	0.839535811	0.118466409	4.336328801
YLD	5.193924051	12.45066287	-121	93
NUM	1.638618093	1.101220349	0	5.087596335
AMT	0.804289933	2.048587107	0.019037015	23.91882093
RTG	11.04968944	3.377871449	0	21

Further, an econometric study was based solely on bond companies. Table 8 provides descriptive statistics for both the variables of the base model and the proposed new variables related to the characteristics of the bond issue.

Then a correlation matrix was constructed in order for the inclusion of new variables in the model to be statistically justified. The obtained values of the sample correlation coefficients were less than 0.7 in absolute value, which indicates the absence of a strong correlation between the explanatory factors. This allows us to proceed to the next step of building a regression model.

CONCLUSION

As a result, a model was chosen to conduct further research to determine whether there is a relationship between the bond issues of the company and its credit risk. Also, it is important to note that in a statistical study, credit ratings assigned by rating agencies were used as a dependent variable. Since credit ratings are based on estimates of the probability of default, expected losses and some qualitative indicators of a borrowing company, ratings can be included in the model as indicators of a company's credit risk.

The paper tested and proved the hypothesis about the applicability of the model of E. Altman in the Russian market. The accuracy of the assessment was set at 93%, and the high probability of bankruptcy for Russian companies was reduced to $Z = 1.23$ compared with 1.8, proposed by Altman directly.

Thus, the Altman model was chosen for further research, since it allows determining the risk of default with high accuracy using available information on the financial performance of companies.

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ALTMAN МОДЕЛЬДЕРІН ТЕСТІЛЕУДІҢ ЭМПИРИКАЛЫҚ НӘТИЖЕЛЕРІ (БАНК СЕКТОРЫ)

Аннотация. Осы зерттеудің талдауы, әсіресе қосымша айнымалы мәндерді қолдану арқылы, елдің нақты бағалауымен жіктеудің дәлдігін айтарлықтай жақсартуға болатындығын көрсетеді. Кейбір ел модельдерінде, қосымша айнымалы материалдар ұсынатын ақпарат жіктеу дәлдігін жоғары деңгейге

көтеруге көмектеседі. Бірінші көпөлшемді банкротты болжау моделін Э.И. әзірледі. Алтман (1968) Нью-Йорктен. Бұл жаңашыл жұмыстың арқасында ақаулардың болжауына көп мәнді көзқарас бүкіл әлемде қаржы, банк және несиелік тәуекел зерттеушілеріне таралды. Ақауларды болжау модельдері банкирлерге, инвесторларға, активтерді басқарушыларға, рейтинг агенттіктеріне және тіпті проблемалық фирмаларға маңызды құралдар болып табылады. Банк секторы экономиканы қаржыландырудың басты провайдері ретінде, несиелік қызметтен пайда алуды арттыру және өздерінің дефолт тәуекелдерін азайту мақсатында жұмыс істемейтін несиелердің деңгейін барынша азайтуға мүдделі.

Түйінді сөздер: кредиттік тәуекелдер, эмпирикалық зерттеулер, нәтиже, модель, банк секторы.

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ЭМПИРИЧЕСКИЕ РЕЗУЛЬТАТЫ ТЕСТИРОВАНИЯ МОДЕЛЕЙ АЛЬТМАНА (БАНКОВСКИЙ СЕКТОР)

Аннотация. Анализ этого исследования показывает, что точность классификации может быть значительно улучшена с оценкой по конкретной стране, особенно с использованием дополнительных переменных. В некоторых моделях стран информация, предоставленная дополнительными переменными, помогает поднять точность классификации на более высокий уровень. Первая многомерная модель прогнозирования банкротства была разработана Э.И. Альтманом (1968) из Нью-Йорка. После этой новаторской работы многовариантный подход к прогнозированию сбоев распространился по всему миру среди исследователей в области финансов, банковских и кредитных рисков. Модели прогнозирования отказов являются важными инструментами для банкиров, инвесторов, управляющих активами, рейтинговых агентств и даже для самих проблемных фирм. Банковский сектор как основной поставщик финансирования в экономике особенно заинтересован в минимизации уровня неработающих кредитов с целью максимизации прибыли от кредитной деятельности и снижения собственного риска дефолта.

Ключевые слова: кредитные риски, эмпирические исследования, результат, модель, банковский сектор.

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