ATLANTIS PRESS
Advances in Computer Science Research (ACSR), volume 85
Third Workshop on Computer Modelling in Decision Making (CMDM 2018)

New Applications of the Annual Fiscal Accounting Analysis at the Risk Assessment

Alexander Alekseev*[0000−0001−5033−6694], Irina Alekseeva[0000−0002−8075−8959],
Alexandra Noskova[0000−0002−7944−1049], Victoriya Kylosova[0000−0002−7912−8888],
Alena Knyazeva[0000−0002−2231−0996]
Perm National Research Polytechnic University, Perm, Russia
*alekseev@cems.psru.ru

***Abstract*—The new applications of annual fiscal accounting analysis at the risk assessment are discussed in this paper. The system analysis methods that can be used to identify the industry or sector of the companies based on their annual fiscal accounting are described. All necessary calculations and computer modeling can be made in the special computer program named The universal cognitive analytics system "Eidos". The industry or sector identification make possible conflict data processing and review of supplier and contractors for identification their main type of economic activity in order to exclude the risk of contracting with an unreliable company. It is very important when choosing a supplier or contractor, and also when banks or credit unions make decisions about the issuance of loans. Other application is financial analysis with taking in to account industry or sector specific in order to make adequate opinions about financial sustainability statement of company or vice versa. Taking into account industry or sector specific make possible to reliably forecasting bankruptcy and assessment of enterprise value for example in cases of mergers and acquisitions. One of the promising applications is the identification of the life cycle stage of the company. An example of the characteristic structure of the balance sheet of Russian construction companies is shown. It is also shown that traditionally recommended ranges of financial ratios are not characteristics of them. The linear equation to assessment of enterprise value of Russian construction companies is shown. Such equation could be used as industry formulas method of business valuation. All applications could reduce the risks of stakeholders and improve the efficiency of decisions making process.**

***Index Terms*—risk assessment, system analysis, fiscal accounting**

I. Introduction

A. The Task of Industry or Sector Identification

For the purposes of this research, the task of industry or sector identification will be defined as follows – determination of the main type of economic activity and specific sector or industry on the basis of its balance sheet or other financial accounting.

This task can be solved with using system analysis methods [1], [2] based on the information theory and all calculations and computer modeling can be make in the special computer program named The universal cognitive analytics system "Eidos" [2]. This program is free for students and researchers. It's available for downloading at the site[1]. These methods are designed to determine class of the identified object and to determine the information importance of the features. The information importance of the features is determined based on frequency of manifestation of features in classes.

In general, these methods are abstract and can be used to study a wide variety of subject areas, so program named as universal system. This program is used by researchers for solving such different problems as: agriculture [3], genetics [4], information [5] and etc.

However this methods and program product have never applied for solving problem of industry or sector identify before.

The authors used the annual fiscal accounting of Russian companies as initial data, but its balance sheets are compiled according to Russian regulations on accounting[2]. Despite attempts to bring Russian accounting rules closer to International Financial Reporting Standards and International Accounting Standards they still differ [6]. That is why the scope of current results has limitation in international practice. However, in this article, the authors sought to show exactly the new opportunities for annual fiscal accounting analysis taking into account industry or sector specific, focusing on the application of these results in the field of risk assessment and risk management.

B. Applications of Industry or Sector Identification at the Risk Assessment

Authors view the next six applications of the task of industry or sector identification based on annual fiscal accounting analysis. All of these applications are directly related to risk assessment. Consider each of the suggested applications in details.

1) Review of suppliers or contractors for determination their main type of economic activity.: Selection of new suppliers and contractors presupposes the existence of the risk associated with the uncertainty of their behavior. For example, the next risks exist when a company works with contractors: delay in the schedule of work, budget overruns, contractors' failure to fulfill obligations and etc.

The risks increase if the opportunistic behavior is present in the implementation of the contract, consequently, there is

[1]Download and start The universal cognitive analytics system "Eidos". http://lc.kubagro.ru/aidos/_Aidos-X.htm

[2]direction of Minfin RF of 06.07.1999 #43n "On approval of the Regulations on Accounting 'Accounting statements of the organization' "

a probability of supply failure, delivery of poor quality goods and etc. As a result, the costs of eliminating opportunistic behavior are increasing, for example, costs of supervision, quality control, legal costs. Also some companies are used for concluding contracts only.

Risk minimization is a check of the contractor (check of experience in the implementation of similar projects, reputation in a certain area). The authors propose to conduct a preliminary audit of the financial statements of the contractors. The goal of the audit is to determine the main activity. The preliminary assessment will reduce the number of potential contractors, therefore, it will reduce the transit costs.

2) Conflicting data processing.: Information and data about companies collected by state or region statistical offices and specialized organizations, such as self-regulating organizations, may differ significantly. It leads to a distortion of information in the development measures and programs to support industry companies.

For example, 9683[3] entities registered in the Perm krai indicated the 45-th class "Construction engineering" according to All-Russian Classifier of Types of Economic Activity. In other words the main types of activity are construction, reconstruction, overhaul and maintenance of buildings and structures including individual house building and repairs. At the same time, only 1974[4] of these entities have a membership in the construction self-regulatory organizations, that is, they have the permits for conducting construction and installation works[5].

Significant difference of statistical data may lead, for example, to non-targeted support of companies and as a consequence, to ineffective spending of state budget funds or reduction funds of programs to support industry companies, while they are really necessary for business entities.

3) Financial analysis with taking into account industry or sector specific.: Traditional methods of financial analysis do not include the industry-specific factor and can lead to the wrong definition of financial stability of the company and vice versa. Therefore, there is a possibility of refusal to Financing of the company's activities or financing at high interest rates, as a result, the lost profit of the credit institution and the deterioration of the borrower.

Risk minimization is the definition of financial ratios, which correspond to the specifics of the industry and the level of development of the national economy.

For example, many companies of construction industry have been working successfully in the Russian market for a long time, but the liquidity and autonomy ratios are low because companies have a high share of receivables and payables.

4) Bankruptcy prediction and forecasting with taking into account industry or sector specific.: A similar situation exists in preventing or predicting bankruptcy. The traditional models such as Altman, Tuffler, Fulmer, Springate, Fox, Fisher, Konan, Lis, Savitskaya, Zaitseva, Belyakova – Davydova, Fedorov – Timofeev and etc, on the one hand, are non-sectoral, on the other hand, the models were determined on the indicators of companies in developed countries. Consequently, the prognostic ability decreases if the models are used for a particular industry for countries of another level of economic development [7]. For example, the construction industry in Russia has a negative dynamics of bankrupt enterprises among other industries: in the three quarters of 2017, 1 951 construction companies were declared bankrupt. This is the historical maximum of this indicator. Moreover, in 2007 the share of construction companies in the total number of bankrupts was 8%, in 2016 the share increased to 20%.

The authors determined the prognostic ability of traditional models for Russian construction companies. As a result, the most reliable is the Springate model, but the model determines the financial position of 67% of the enterprises from the sample only [7]. Then authors created the bankruptcy prediction model with using the cognitive analytics system "Eidos" and prognostic ability of the model is 92% [8].

Risk minimization is the definition of financial and economic performance indicators that take into account the peculiarities of the national economy and the industry to build models for predicting bankruptcy.

The dynamics of growth of the number of Russian construction companies in the active stage of bankruptcy is presented in Fig. 1.

5) Business valuation.: Business valuation is widespread in many applications, not only in providing shareholders and management of the company with information about the value of their company or a stake, but also in the management of a portfolio of shares, due to diligence, mergers and acquisitions and etc.

The risk of assessing a business without industry characteristics analysis lead to underestimation or overestimation of value of company, consequently, making wrong management decision. This risk is typical for countries with developing economies, including Russia. It is necessary to continuously update the industry coefficients and one of the methods of direct market comparison approach – industry formulas method is not applied in practice.

The authors propose to mitigate this risk through the identification of the most characteristic item on a balance sheet for industrial enterprises and the establishment of new multipliers or create the regression equation between the balance sheet and company value / share price.

6) The stage of life cycle of an enterprise.: It is well-known that the company may have specific threats at different stages of life cycle [9], [10]. Financial ratios, taking into account the specifics of the industry, allow us to assess the current

[3]Distribution of companies and organizations by types of economic activity in Perm Krai http://permstat.gks.ru/wps/wcm/connect/rosstat_ts/permstat/resources/acfc2c0040a5b22ba63fe7367ccd0f13/10.1.html accessed 2018/07/26

[4]Register of self-regulating organizations in Perm city and Perm Krai https://perm.reestr-sro.ru accessed 2018/06/01

[5]Not all the types of construction and installation work require membership in the self-regulatory organizations and have the permits. List of works that do not require membership in self-regulatory organization available at https://glavsro.ru/a117516-kogda-nuzhno-vstupat.html accessed 2018/07/30

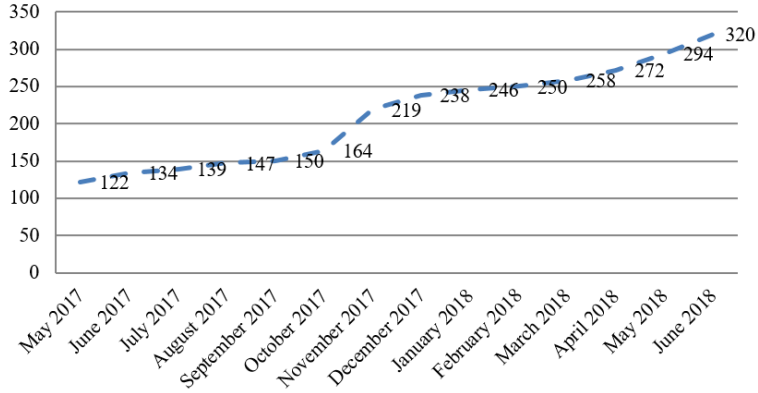

Fig. 1. Dynamics of growth of the number of developers in active bankruptcy procedures, Source: erzrf.ru

state of the company, that is, to determine the phases of the life cycle and the use of the Boston consulting group matrix [11], innovation snail [12] and in the future, the assessment and development of measures to improve the efficiency of the company.

The list of suggested applications may be expanded or shortened in future.

According to the results of the review of publications and studies, the authors did not find the proposed applications based on the analysis of industry-specific features of accounting, of course, except of financial analysis and bankruptcy forecasting. However, the attempts of other researchers to build industry models (see [13], [14]) are based on a single methodological tools for solving all applications – the universal cognitive analytics system "Eidos" described in subsection 2.1. Therefore, the authors considered the proposed applications to be new, which is reflected in the title of this paper.

II. Data and Methods

A. Methods and Models

This study was realized with using the next particular models of information importance of features (Table I). Information importance of the features determines based on frequency of manifestation of features in classes. The information importance of the features helps to identify different classes of objects.

These methods are abstract. Therefore, we explain what is meant by objects, features and classes in this article. At the all applications of the annual fiscal accounting objects mean companies, features mean the relative values in percentage of the balance sheet items. Classes of objects mean industry or sector names for review of suppliers and contractor (first application), conflicting data processing (second application) and business valuation (fifth application). At the tasks of financial analysis (third application) and bankruptcy predicting (fourth application) the classes of objects mean financial stability and instability (bankrupts) company. At the last application classes of objects mean stage of life cycle.

All calculations were making in the special computer program "Eidos" created by the professor Lutcenko E.V. from Kuban State Agricultural University.

Particular models of information importance of features have the following form:

$$I_{ij} = \Psi(\log_2(N_{ij}N) - \log_2(N_iN_j)), \tag{1}$$

$$I_{ij} = N_{ij} - N_iN_j/N, \tag{2}$$

$$I_{ij} = (N_{ij}N)/(N_iN_j) - 1, \tag{3}$$

$$I_{ij} = N_{ij}/N_j - N_i/N, \tag{4}$$

where I_{ij} – value of information importance of i-th features for j-th class; i – number of features (in this research – a certain range of the enterprise balance sheet in relative terms); j – number of class (in this research class is mean industry or sector, in case of bankruptcy prediction we used only two classes: companies are bankrupts and companies are not bankrupts); N_{ij} – amount i-th features in j-th class in training sample; N_i – amount i-th features in training sample; N_j – amount j-th class in training sample; N – volume of training sample; Ψ – normalization factor transforming amount of information in formula named after A. Kharkevich in bits and ensuring for her compliance with the correspondence principle with R. Hartley's formula.

Normalization factor Ψ is calculated by the following form:

$$\Psi = \log_2 W^{\varphi} / \log_2 N, \tag{5}$$

where W – volume of all classes, φ –Hartley's emergence rate calculated by the following form:

$$\varphi = \log_2 \sum_{m=1}^{M} C_{W^m} / \log_2 W, \tag{6}$$

where M – volume of all classes.

A direct assessment of the ownership of a company to an industry or sector class is calculated according to the following formula:

$$B_j = \sum_{i=1}^{M} L_i I_{ij}, \qquad L_i \in \{0,1\}, \quad i = 1, \ldots, M \tag{7}$$

TABLE I
MODELS USED IN UNIVERSAL COGNITIVE ANALYTICS SYSTEM "EIDOS"

Designation	Name of model[§]	Equation	Note
INF1	Amount of information in formula named after A. Kharkevich	(1)	N_j – volume of features in j-th class;
INF2		(1)	N_j – volume of objects in j-th class;
INF3	The difference between the actual and theoretically expected frequencies	(2)	
INF4	Return on Investment[¶]	(3)	N_j – volume of features in j-th class;
INF5		(3)	N_j – volume of objects in j-th class;
INF6	The difference between the conditional and unconditional relative frequencies	(4)	N_j – volume of features in j-th class;
INF7		(4)	N_j – volume of objects in j-th class;

[§] All of these models called by Professor Lutcenko E.V.
[¶] This model is called "Return on Investment" by Professor Lutcenko E.V., but it isn't investment term

where L_i – variable describing the presence of ($L_i = 1$) or absence ($L_i = 0$) features i at the analyzing object (in this research – analyzing company).

B. Initial Data

The specific weight of the balance sheet items was used to identify the industry as an information signs[6]. The final result was obtained by normalizing the articles in relation to the balance sheet.

The study uses 30 items of assets and liabilities. Each of the articles was divided into 10 segments, as a result, 300 features were formed, with the help of which it was planned to identify the industry. The study was conducted on the basis of accounting data of 500 enterprises belonging to five sectors of the economy: Construction, Mining, production of chemicals and products, Agriculture and forestry, as well as Information and communication technologies and communications.

For forecasting of bankruptcy of the initial data was taken as 200 Russian companies in the construction industry. 100 enterprises of the sample were liquidated or are under liquidation due to bankruptcy. The other 100 enterprises are economically prosperous, for which bankruptcy cases were not opened. In order to assess the financial stability of enterprises on the basis of the models data of their balance sheet and statement of financial results were taken. For the companies which are bankrupts the financial statements for the year preceding the year of the beginning of the bankruptcy case are used, for "healthy" companies there were financial statements of the year 2015.

III. RESULTS

The parameters of the mathematical model were identified using the universal cognitive analytical system "Eidos". This model allows you to determine the industry affiliation of the enterprise based on the structure of its balance sheet.

Table II presents an example of a typical structure of the balance sheet of Russian construction companies.

Typical ranges of the coefficients of the financial analysis of the Russian construction companies are presented in Table III.

Based on the balance sheets of training sample using "Eidos" 270 intervals of values of balance sheet items were determined, that is, each of the 27 main items of the balance sheet was divided into 10 intervals. Intervals characterize a certain financial position of the construction company.

The most typical articles of the balance sheet and ranges of values of these articles are discussed below (Table IV and Table V).

The purpose of study included showing that assets in balance sheet would be enough for business market value assessment. Preliminary results of regression analysis prove assets (without liabilities) can be explaining business market value changes. Data on the market value of shares in public companies is a training sample of the model. The explaining variables were selected accounting assets, which the mostly characterize construction companies (see, Table II), but the final model (8)[7] includes untypical assets too, for example, intangible assets. This model (8) can be used as an express method of assessment of the Russian construction companies' market value (enterprise value).

[6] direction of Minfin RF of 05.10.2011 #124n "On the introduction of changes in the forms of financial statements of organizations approved direction of Minfin RF of 02.07.2010 #66n"

[7] The initial data for the construction of the regression equation were the data, which are recorded according to the Russian accounting rules. The equation cannot be used to estimate the value of shares of companies that carry out accounting under IFRS. Model's parameters were identified based on data of 2016 year. It's necessary that model's parameters regular actualize and it cannot be used in current period.

TABLE II
TYPICAL STRUCTURE OF THE BALANCE SHEET OF RUSSIAN CONSTRUCTION COMPANIES

Assets	0-.05	.06-.10	.11-.15	.16-.20	.21-.25	.26-.30	.31-.35	.36-.40	.41-.45	.46-.50	.51-.55	.56-.60	.61-.65	.66-.70	.71-.75	.76-.80	.81-.85	.86-.90	.91-.95
Fixed assets																			
Short-term financial investments																			
Income yielding investments into tangible assets																			
Deferred tax assets																			
Other non-current assets																			
Inventories																			
Value added taxes																			
Accounts receivable																			
Cash and cash equivalents																			
Other current assets																			
Equity																			
Deferred tax liabilities																			
Other long-term liabilities																			
Long-term borrowings																			
Accounts payable																			
Deferred revenues																			
Other short-term liabilities																			

* Red color shows intervals of the most typical values of the assets and liabilities, rose color is intervals of typical values and white color – untypical values.

TABLE III
TYPICAL RANGES OF THE COEFFICIENTS OF THE FINANCIAL ANALYSIS OF THE RUSSIAN CONSTRUCTION COMPANIES

Ratio	0-.05	.06-.10	.11-.15	.16-.20	.21-.25	.26-.30	.31-.35	.36-.40	.41-.45	.46-.50	.51-.55	.56-.60	.61-.65	.66-.70	.71-.75	.76-.80	.81-.85	.86-.90	.91-.95	.96-1
debt-to-equity ratio																				
cash ratio																				
quickratio																				
current ratio																				

* Red color shows intervals of the most typical values of the financial ratios, rose color is intervals of typical values and white color – untypical values.

TABLE IV
THE MAIN FEATURES OF ENTERPRISES-BANKRUPT CONSTRUCTION INDUSTRY

No.	Name of balance sheet item	Specific weight in total assets	Force of influence of feature, calculated with using model (2)
1	Short-term financial investments	30–40%	9.498
		40–50%	7.999
		20–30%	7.498
2	Cash and cash equivalents	<6%	8.484
3	Fixed assets	<8%	5.490
4	Equity	<0%	7.498
5	Short-term liabilities	>98%	5.996

TABLE V
THE MAIN FEATURES OF "HEALTHY" ENTERPRISES OF THE CONSTRUCTION INDUSTRY

No.	Name of balance sheet item	Specific weight in total assets	Force of influence of feature, calculated with using model (2)
1	Short-term financial investments	0–10%	41.009
2	Retained earnings	>16%	10.504
3	Accounts payable	<37%	10.004
4	Short-term liabilities	7–52%	9.003
5	Equity	<42%	8.514

$$EV = IA \times 1.73 + FA \times 0.15 - FI \times 0.05 - \\ - IY \times 0.23 + DTA \times 1.16 + In \times 0.73 + \\ + CA \times 0.20 + VAT \times 0.80 - 30984, \quad (8)$$

where EV – enterprise value of Russian construction engineering company, IA – intangible assets, FA – fixed assets, FI – short-term financial investments, IY – income yielding investments into tangible assets, DTA – deferred tax assets, In – inventories, CA – capital assets, VAT – value added taxes.

The explanation of negative effect of the multipliers of short-term financial investments (FI) and income yielding investments into tangible assets (IY) needs additional research.

The resulting model should be referred to the class of models of industry coefficients, widely used in countries with developed economies. The proposed method should be referred to direct market comparison approach. Express-method can be used not only to assess the market value of the business, but also as a basis for decision-making by investment companies. The method makes it possible to assess the level of market value of assets in the portfolio. In addition, this technique will create models of bankruptcy forecasting for domestic enterprises of various industries. The models will take into account the specifics of the economic activity of enterprises. This is certainly an actual topic for the study.

IV. CONCLUSION

The new applications of annual fiscal accounting analysis at the risk assessment are discussed in this paper. The system analysis methods that can be used to identify the industry or sector of the companies based on their annual fiscal accounting are described. The industry or sector identification make possible conflict data processing and review of supplier and contractors for identification their main type of economic activity in order to exclude the risk of contracting with an unreliable company. It is very important while choosing a supplier or contractor, and also when banks or credit unions make decisions about the issuance of loans. Another application is financial analysis with taking into account industry or sector specific in order to make adequate opinions about financial sustainability statement of company or vice versa. Taking into account industry or sector specific makes possible to create reliably forecasting bankruptcy and assessment of enterprise value for example in cases of mergers and acquisitions. One of the promising applications is the identification of the life stage of the company.

REFERENCES

[1] E. V. Lutsenko, "Conceptual principles of the system (emergent) information theory and its application for the cognitive modelling of the active objects (entities)," in *Proceedings of IEEE International Conference on Artificial Intelligence System 2002*, V. G. Zakharevich and V. M. Kureichik, Eds. Los Alamos: IEEE Computer society, 2002, pp. 268–269.

[2] ——, *The universal cognitive analytics system "Eidos"*. Krasnodar: Kuban State Agrarian University, 2014.

[3] T. P. Baranovskaya, V. I. Loiko, A. Y. Vostroknutov, E. V. Lutsenko, and A. G. Burda, "Developing a business model and a strategy map for objectives in the enterprise architecture of an agro-industrial corporation," *International Journal of Applied Business and Economic Research*, vol. 14, no. 9, pp. 6015–6037, 2016.

[4] L. P. Troshin, A. S. Zviagin, A. V. Milovanov, and E. V. Lutsenko, "Application of the automated system-cognitive analysis for solving problems of genetics," *Journal of Mechanical Engineering Research and Developments (JMERD)*, vol. 41, no. 2, pp. 1–8, 2018.

[5] A. Artemov, E. V. Lutsenko, E. Ayunts, and I. Bolokhov, "Informational neurobayesian approach to neural networks training. Opportunities and prospects," 2017, arXiv preprint arXiv:1710.07264. [Online]. Available: https://arxiv.org/pdf/1710.07264.pdf

[6] A. S. Prozova and T. A. Martynova, "The difference in the understanding of the characteristics of information between IFRS and RAS as a problem of strategic analysis information support," *Economics: Yesterday, Today and Tomorrow*, vol. 5, no. 6, pp. 74–81, 2013.

[7] A. R. Noskova and A. O. Alekseev, "The study of prognostic models estimates of the bankruptcy probability is in relation to the construction industry," *Corporative economics*, vol. 2, no. 14, pp. 10–17, 2018.

[8] ——, "Reliable prediction of the probability of bankruptcy of enterprises in the construction industry using the method of systemic-cognitive analysis," *Financial risk management*, vol. 3, no. 55, pp. 218–224, 2018.

[9] I. Adizes, *Managing Corporate Lifecycles: An updated and expanded look at the Corporate Lifecycles*. Paramus: Prentice Hall Press, 1999.

[10] ——, *Managing corporate lifecycles: how to get to and stay at the top*. Santa Barbara: The Adizes Institute Publishing, 2004.

[11] B. Henderson, "The product portfolio: growth share matrix of the Boston consulting group," in *The Strategy Process: Concepts, contexts, cases*, H. Mintzberg and J. B. Quinn, Eds. Upper Saddle River, NJ: Prentice Hall, 1979, pp. 678–680.

[12] N. A. Badulin, "Economic theory of relativity or "innovation snail"." [Online]. Available: https://www.triplehelixassociation.org/wp-content/uploads/2015/09/150615_Innovation_Snail-Article-.pdf

[13] E. A. Fedorova and Ja. V. Timofeev, "Developing the bankruptcy prediction models for russian businesses of the construction and agriculture industries," *Finance and credit*, vol. 32, pp. 2–10, 2015.

[14] M. Karas and M. Reznakova, "Predicting the bankruptcy of construction companies: A CART-based model," *Engineering Economics*, vol. 28, no. 2, pp. 145–154, 2017.