Для развития регионов второго кластера также необходима инвестиционная стратегия, но с учетом специфики этих регионов. В связи с тем, что области, попавшие во второй кластер, традиционно отличаются высоким товарооборотом розничной и оптовой торговли (в частности, Харьковская, Одесская и Львовская области), а также в связи с тем, что во многих из этих областей находятся крупные транспортные узлы, приоритетом развития этих регионов является сфера услуг. Особенность этой группы заключается в возможности подняться к первому кластеру, так и в вероятности спуститься к третьему. Эти области имеют повышенный уровень социально-демографического и финансового рисков.

Регионы третьего кластера, например, такие, как АРК и Ивано-Франковская область несут в себе большой потенциал по развитию рекреационной сферы. В связи с этим, в регионах третьего кластера следует уделять большое внимание развитию туризма и других видов деятельности по оказанию услуг. Кроме того, следует обратить внимание на низкий уровень промышленного развития таких областей, как Винницкая, Николаевская и Черкасская, что требует осуществления внутренних инвестиций и привлечения зарубежных инвесторов в развитие предпринимательства в этих регионах.

Уровень социально-экономического развития регионов четвертого кластера является достаточно низким. Более того, традиционно эти регионы считаются "реципиентами", то есть потребляют больше бюджетных средств, чем направляют их в бюджет. Сюда вошли как аграрно-индустриальные Волынская, Закарпатская, Ровенская, Тернопольская и Черновицкая области, так и Сумская, Херсонская, Житомирская, Черниговская, Кировоградская области и г. Севастополь, обладающие наиболее изношенной непродуктивной производственной базой. Хмельницкую область многие эксперты оценивают как область с умеренным потенциалом и высокими рисками, среди которых – экономический, финансовый и социально-демографический. Мероприятия по их сокращению, а также увеличению доли услуг в структуре экономики позволит улучшить ее показатели. Значит, основной задачей для регионов четвертого кластера является повышение эффективности функционирования их предприятий и привлечение дополнительных инвестиций за счет собственных ресурсов.

Таким образом, выполненная кластеризация регионов Украины в зависимости от показателей социально-экономического развития и внешнеэкономической деятельности свидетельствует о существенной их дифференциации. Более высокий уровень ВЭД способствует повышению соцально-экономического развития региона. Это свидетельствует о необходимости формирования дифференцированных программ развития внешнеэкономической деятельности, учитывающих особенности отдельных регионов. А поскольку национальная экономика является частью динамичной системы мирового хозяйства, то чем активнее страна включается в систему мирохозяйственных связей, тем точнее выверен ее курс взаимодействия с остальным миром, тем выше благосостояние общества и его граждан.

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NEW DIRECTIONS OF BUSINESS STATISTICS IN FINANCE AND AUDITING

The classical approach in applications of business statistics offers a various statistical techniques for solving economic and managerial problems. A typical handbook in business statistics contains regular presentation of statistical techniques, starting from descriptive statistics through regression analysis, probability theory, statistical inference to time series analysis. This type of presentation is not useful for users, because on the first place put statistical methods, but not problems which could be solved using statistical methods. The proper approach is first to define a real economic or managerial problem and then, look for an appropriate statistical techniques. Problem oriented approach is presented in this paper.

As the first example, a real problem in auditing is presented. On which principle an auditor can decide that considered financial statement gives a true and far view on financial situation and results of economic activity of investigated firm. A useful tools for answering the question are tests of controls and significant tests in auditing. All this methods based on statistical approach, but not a classical one. The specificity of these methods are presented in the paper.

As the second example an important economic problem of bankruptcy prediction has been presented. The knowledge about risk of firm collapsing is very important for owners, managerial staff, employees, banks and other market institutions. The basic methods for firms bankruptcy prediction are: multivariate discriminante analysis models, Logit models and neural networks models. A history of mentioned above methods is presented.

Keywords: business statistics, statistical methods in auditing, statistical tests in auditing, bankruptcy prediction models.

1. Classical approach to business statistics

Traditionally understood course of business statistics contains a regular course of statistics with applications to the analysis of business and managerial problems. In this sense business statistics differs from, let's say medical statistics, only in area of application. Statistical methods are the same but areas of application are different. In fact, statistical methods are universal with possible applications in areas of natural sciences, social sciences, economics and business, psychology, humanities. In consequence, classical approach in applications of business statistics offers a various statistical techniques for solving economic and managerial problems.

A typical handbook of business statistics in English (see for example: [2], 5] or [15]) contains the following chapters: Introduction to statistics (What is statistics, Data and statistics), Charts and graphs, Descriptive statistics, Introduction to probability, Discrete distributions, Continuous distributions, Sampling and sampling distributions, Introduction to statistical inference, Interval estimation, Hypothesis testing, Analysis of variance and design of experiments, Analysis of categorical data, Nonparametric statistics, Regression analysis, Index numbers, Time series analysis. These chapters collect a general descriptive statistics and statistical inference methods. The only specific chapter in each handbook, oriented toward business and economics is: Statistical Quality Control.

A popular handbook in statistics for economists and managers in Polish [26] also contains traditional sequence starting from essence and subject of statistics through descriptive structural analysis, interdependence analysis, dynamic analysis, to probability theory, random variables and their theoretical distributions, estimation theory and hypothesis testing theory.

A similar structure for statistical methods presentation we can find in many handbooks in various languages. For example a handbook in Slovakian [20] has a similar structure: principle of statistics, description of one-dimensional statistical population, principles of probability theory, principles of statistical inference, statistical investigation of dependence, time series, statistical comparisons.

In all mentioned above handbooks of business statistics a sequence of statistical methods depends on logical presentation the theory of statistics, probability theory and statistical inference theory. This is methodologically oriented approach to business statistics. This type of presentation is not useful for users, because on the first place put statistical methods, but not problems which could be solved using statistical methods. This is the first, among many other reasons, that statistical methods are not enough frequently used as a tool for business and management analysis. We, statisticians look like salesmen, who want to sell statistical methods, but we are not sure if they will be useful for buyers.

The proper approach is first to define a real economic or managerial problem and then, look for an appropriate statistical techniques for solving the problem. This is problem oriented approach in statistical investigations. It ought to be preferred, when we want propagate statistical methods in business analyses.

A new, contemporary important directions of business statistics, are applications of business statistics methods in auditing and bankruptcy prediction. These. problem oriented approaches, are presented in the paper.

2. Statistical inference methods in auditing

Probability theory and sampling methods are useful tools in auditing. Gathering audit evidence typically involves sampling, testing and examining data interrelationships. Sampling means selecting transactions to examine rather than examining all transactions that occurred during the period or all accounts with balances at year end. Testing means that auditors do not exhaust every effort to determine that a balance is correct. Instead they gather and evaluate evidence to serve as a reasonable basis for an opinion. Examining the relationships between data means performation a reasonably detailed study of a document or record to obtain the opinion about correctness of audited transaction [13].

In probabilistic approach an auditor have to assume the type of distribution models in auditing. Statistical inference methods in auditing are based on assumption of a certain distribution of errors or deviations in the population of transactions or all components of an account balance. The common assumption is, that it is binomial distribution model for appearance of a single error, Poisson's distribution for a certain number of deviations in investigated population or normal distribution model for a quantitative measures of errors or incorrectness. That means that all methods of estimations and hypothesis' testing are based on models of binomial, Poisson's or normal distributions [11].

Statistical sampling is a sampling technique in which an auditor uses the laws of probability to select and evaluate a sample. When using statistical sampling, auditors must select a random sample, which means every item in the population must have an equal chance of being included in the sample. Using audit sampling methods an auditor must take into account an audit risk. This is the risk that an auditor may unknowingly fail to appropriately modify an opinion on financial statements that are materially misstated.

Estimation methods are used both as a point estimates and interval estimates for estimation of proportion of errors or deviations to the whole sampled transactions i.e. estimate the probability of appearance of various kinds of errors or irregularities. Auditors also estimate mean value and standard deviation of differences between observed and correct values of transactions, applying point estimate and interval estimate methods.

Statistical hypothesis testing in auditing are important tools of auditors. That kinds of procedures are used to determine whether the hypothesis is a reasonable statement and should not be rejected or is unreasonable statement and should be rejected. In rejection or acceptation of null hypothesis an auditor is under a risk of incorrect decision. We can define problems of auditing in terms of statistical testing theory, what allows an application of probability theory procedures and statistical inference methods. Then we can use results to manage a certain risk. Simplifying, we can put the null hypothesis that statistically verified financial statement "is good" against the alternative hypothesis, that the statement "is bad". We can make mistakes, which are classically illustrated as in table 1.

***Table* 1. Types of errors in testing of statistical hypotheses**

Researcher	**Null hypothesis**	
	H_0 is true	H_0 is false
Accepts H_0	Correct decision	Type II error (risk of β type)
Rejects H_0	Type I error (risk of α type)	Correct decision

The peculiarity of statistical tests application in auditing is, that more important is risk of acceptation of "bad" statistical statement (risk β type), related to the effectiveness of audit procedure, than rejection of "good" financial statement (risk of α type). This is the reason that classical significance tests, based on assumed significance level (α), are usually not applicable in auditing. In confirmation of financial statement is more important the

possibility of assignment *a priori* the level type II error (risk of β type). Each significance test can be transformed to the form, in which we can *a priori* assume the level of β [11]. There is the problem how to define the null hypothesis H_0 and the alternative hypothesis H_1 in concrete audit procedures. There are two groups of audit tests: tests of controls and substantive tests, which define the null and the alternative hypotheses in different ways.

Tests of controls are audit procedures performed to determine whether an internal control system is existing and operating in the firm. They are tools for testing the effectiveness of a control structure policy [13]. Auditor identifies specific control procedures relevant to individual assertions that are likely to prevent or detect material misstatements in those assertions. Then the auditor performs tests of those control procedures to evaluate their effectiveness. There are three popular procedures of tests of controls: attribute sampling, sequential attribute sampling and discovery sampling. The idea and probabilistic foundations of test of controls were presented for example at [21] and they are not subjects of this paper.

Substantive tests are those in which the feature of audit interest is the amount of monetary misstatement that would affect the financial statements being audited, including those due error and fraud. By definition, therefore substantive tests are concerned with reaching conclusions about whether financial amounts are materially correct.

There are two possible approaches to substantive tests [11]. One of them is Probability Proportional to Size sampling (PPS) method. The second one is a group of classical variables sampling techniques, which contains mean per unit estimation (MPU), difference estimation and ratio estimation method. The most popular in practice is probability proportional to size sampling method, which is a sampling technique auditor use to estimate the maximum amount of overstatement of recorded amount with measurable levels of risk of making a decision error. PPS sampling method gets its name from the fact that the probability of a physical item's being selected for inclusion in the sample is equal to its size in proportion to the size of the whole population.

The third area of statistical inference methods application is analytical review [11]. Analytical review procedures is the set of procedures that compares relationships between data to determine the reasonableness of recorded amounts. The basic statistical tool which is used in this area, that is regression model.

3. Statistical methods for bankruptcy prediction

The issue of bankruptcy prediction is usually discussed from different points of view, demonstrated by the following entities:

– company management, which constitutes the basis for economic decisions,

– the bank – in the lending decision process,

– the auditors – in the process of auditing financial statements,

– the investor and financial analyst – in the process of making investment decisions on the capital market,

– government institutions and economic organizations – which assess the economy's condition.

Statistical model for bankruptcy prediction is a useful tool for assessing the likelihood of the company's failure. Such a model is part of the early warning system for predicting the company's economic and financial standing. Most of bankruptcy prediction procedures and models may be viewed as broadly understood data classification methods. The typical classification of bankruptcy prediction models [22] is as follows:

univariate ratio models,
multiple discriminant analysis,
linear probability models,
multivariate conditional probability models (Logit and Probit),
recursive partitioning models,
survival analysis (proportional hazard model),
expert systems,
mathematical programming,
neural networks,
genetic algorithms.

The basic methods for bankruptcy prediction is ratio analysis, understood as conventional ratio analysis (liquidity, solvency, profitability, leverage, debt) or as Beaver's univariate ratio model [3], in which is concluded that the cash flow to debt ratio was the best single ratio predictor. An alternative to that is construction of synthetic variable.

The most popular tool for bankruptcy is multivariate discriminant analysis. The first in the world, who applied Fisher's linear discriminant function as a tool for bankruptcy prediction was E. Altman [1]. After political changes at 1989 in Poland and Balcerowicz's economic reform at 1990 towards market economy, bankruptcy appears as a serious problem in the country. So, also in Poland linear discriminant models have been constructed and estimated. The first discriminant model was published by Mączyńska [16]. The main followers were [8, 9, 10, 12].

The second place according the frequency of applications, as a tool of bankruptcy prediction, take Logit and Probit models. The first in the world, who used Logit model for bankruptcy prediction was Ohlson [19]. The first who proposed Probit model as a tool for bankruptcy prediction (X-score) was Zmijewski [27]. In Poland, the first who applied Logit model for bankruptcy prediction of Polish firms were Stępień and Strąk [24]. The most comprehensive works on bankruptcy prediction, using binomial Logit models are presented in [6, 7 or 25].

Neural networks as a tool for bankruptcy prediction were used since nineties of the last century. One of the first publications were [4 and 18]. First proposals of neural networks applications for bankruptcy prediction of Polish firms were contained in [17]. Later and more complex published works on theory and applicationof neural networks are presented at [14 and 23]. The logistic form of activation function and back propagation error algorithm have been used in this works.

Three arises a problem which method ought to be chosen for bankruptcy prediction. It leads to efficiency investigation of bankruptcy prediction models. The comparative analysis does not lead to any clear-cut conclusions as to the effectiveness of the particular bankruptcy prediction models [22]. Some authors are in favour of neural networks; they claim that they are more flexible and demonstrate the highest potential for correct classifications. However, there is enough evidence to claim that the classical linear discriminant function may be more effective than complex neural networks. In closing, it may be stated that the correctness of bankruptcy predictions is not dependent on the type of a prediction model. The level of correctness may be raised by the inclusion of the external factors which affect the company's financial standing. The most important among them is a current stage of business cycle. Prediction models presented above do not consider possibly significant impact of business cycle.

Since it is hardly possible to determine the most appropriate models for predicting bankruptcy, two

fundamental questions should be posed: (1) what is the reliability of bankruptcy prediction for a specific company? In a statistical sense, an answer to this question is offered by the prediction error. However, does it comply with the classical methods for defining and calculating the average prediction error? This leads to another question: (2) what is the nature of errors committed in the process of predicting the corporate failure?

In this context, the sources of errors in the bankruptcy prediction process should be investigated. One of them is the value-related character of financial ratios. Of course, national and international accounting standards are available, but the measurement of financial values is still far from being unified. Such problems occur both at the national and international level. For example, the annual reports published by listed companies are either only non-consolidated or both non-consolidated and consolidated. In the latter case, consolidated reports are usually available for shorter periods of time than the non-consolidated ones. Additionally, reports comply with different accounting standards. Some of the annual reports of listed companies refer to the Act on accounting, the others comply with IAS or Polish accounting standards. The accuracy of measuring financial ratios as variables classifying bankrupts and non-bankrupts is limited.

Another possible source of errors is a method for selecting samples. In the classical approach population samples are randomised, and because the populations of companies are not very large, selection would require independent random samples. In practice, the investigated populations are not based on random samples. Information on insolvent companies is based on all the failures filed by court registers in a given period of time, so the analysis covers the entire population, not specific samples. The events of failures are matched with well performing companies with similar parameters on the basis of non-randomised methods. Therefore, this is not the case of randomised selection in the classical sense, and consequently, sampling errors. The tested classification error does not result from the application of random samples.

Errors in bankruptcy prediction are often caused by the cases of so called strategic bankruptcy. The management boards or owners of well-performing companies may intentionally drive their companies into bankruptcy after protecting their assets in tax havens. None of bankruptcy prediction models considers the case of management boards intentionally driving their companies into bankruptcy.

Other errors may be caused by the instability of the investigated populations. The populations of bankrupts and well-performing companies in the periods of economic boom are not identical with the same populations at the time of the economic crisis. Therefore, the prediction error may result from the fact that the model is based on the data from the period of the economic boom, while the prediction itself is developed for the company in recession. It should be considered, then, whether the inclusion of business cycle factors into prediction models raises their prediction ability.

The above considerations lead to the conclusion that the bankruptcy prediction process should not solely rely on the historical financial ratios. Changes to the company's economic environment have a significant impact on its current financial standing and its ability to operate as a going concern. The correctness of bankruptcy predictions heavily relies on the company's rapidly changing business environment. Business cycle factors should also be included in the bankruptcy prediction process.

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