



Audit Risk Assessment Model in Automated Accounting Systems of Enterprises in Ukraine

Ponomarenko Oksana¹✉, Kantsedal Nataliya¹ , Aranchiy Valentyna¹ ,
and Ostapchuk Serhii²

¹ Poltava State Agrarian Academy, Poltava, Ukraine

{oksana.ponomarenko,nataliia.kantsedal,pdaa}@pdaa.edu.ua

² National Scientific Centre “Institute of Agrarian Economics”, Kyiv, Ukraine

ostapchuk@faaf.org.ua

Abstract. The topicality of searching tools to minimize (neutralize) the probable consequences of information risk of financial reporting users in data processing computing environment requires components’ revision of the traditional multiplicative risk assessment model by auditor. The result of the research is confirmed by two inter-complemented hypotheses: theoretical (about the necessity to expand the classical model of audit risk assessment) and empirical (about the expediency of using intellectual analysis methods of reporting in audit). The aim of the study is to substantiate the needs and formalize the procedures of expanding the components of traditional multiplicative model of audit risk assessment in computer systems processing accounting data of audit’s client to reduce the level of information risk for financial reporting users.

Practical value of the authors’ approach consists in increasing formalization level of auditor’s professional opinion and substantiating the size of audit samples. This enables to reduce information uncertainty of interested users of financial statements.

It is proven that using multifactor models of correlation-regression analysis will make it possible for auditor to predict the values of report items that can be an instrument of manipulation and distortion of enterprises’ financial statements.

Keywords: Audit risk · Detection risk · Multiplicative model · Automated accounting systems · Mathematical-statistical methods

1 Introduction

Modern economic realities pose conditions before financial reporting users to make decisions under the influence of generated information risk generated, which is caused by restrictions affecting information provision of rational managerial decisions.

The mentioned limitations arise because information flow of accounting data is not neutral. It is specific and therefore not completely reliable. In addition, all accounting information is influenced by the human factor, dynamic regulations and similar negative factors.

Today audit evidence is the most reliable tool to minimize (neutralize) probable consequences of information risk for financial statements' users.

Overcoming the problem of subjectivity and approximation of auditor's estimation under information uncertainty of financial reporting users envisages digital substantiation of auditor's professional opinion by applying formalized approaches. Rational risk assessment is the way to real decreasing the cost of audit services through reducing time to conduct procedures.

The formalization of audit process in general and audit risk assessment in particular, enables to make the process of training auditors more accessible owing to facilitating the understanding of audit processes; logically justify the conducting of selective study and its volume; to organize effective auditing by the team, in which not all members are highly qualified. However, in practice informal approaches dominate, the main reason of which is the necessity to invest additional funds in personnel training. Such approach will necessarily lead to saving in the long-term prospect, but it is not included in short-term interests of the national audit firms. In our opinion, the importance of formalized risk assessment will increase in the process of audit development due to the fact that risks are manageable.

2 Literature Review and Theoretical Research Model

Since the adoption of the Law of Ukraine "About audit activities" national auditors have addressed many-year world experience, and the notion of "risk in audit" has been strongly established in their professional life as an effective instrument for sample studies. Positive is the fact of permanent renovating scientific-practical developments concerning risk-oriented approach by a number of Ukrainian scientists and economists from foreign countries [1–4].

Scholars mostly consider theoretical aspects of audit risk (components, general definitions and formulations) and pay not enough attention to introducing risk-oriented approach in practice.

Thus, scientific notions concerning audit risk issues have evolved since the first attempts to use the category of "probability" in reference to audit. In 1933, A. Carman introduced multiplicative models in the following form [4] before their appearing in standard 47 "Audit risk and essentiality in audit" of the American Institute of Chartered Accountants.

The research and clarification of determinants facing auditor during verifying accounting computer system information were conducted by a group of Jordanian scientists Al-Bashtawi Suliman Hussein and Al-Husban Atallah [5].

Automation of customer's accounting brings additional audit risks.

The research conducted by Otieno Polo. J. and Dr Oima D. [6] based on questioning representatives of 41 enterprises confirm that in 17% of companies the volume of information provided for audit is previously agreed at senior management level. In fact, it means that in such a case the degree of auditor's significant restrictions objectively grows before the beginning of verification. Accordingly, audit risk management is significantly connected with risk assessment and determination. In this aspect, not computer systems,

but their immediate users are considered by the above mentioned authors to be potential weak sides creating conditions for audit determinations (limitations) in computing environment.

In addition to unquestioning advantages of automated system for accounting information processing, there are several serious drawbacks and threats in terms of data security and vulnerability to fraud, especially in the global network and using remote access technologies.

So, Osim E. Etim considers that financial statements prepared by administration cannot be considered completely impartial and objective in case of substantiating the selection of research direction [7, 22].

With this aim, as Osim E. Etim notes, the questioning of 40 practicing auditors was conducted at the Faculty of Business Administration of the University of Uyo (Nigeria), the probability of distributing its results among the whole audit community in the country was confirmed by using the central finite theorem and Kolmogorov-Smirnov's test. It was revealed that only 42.5% of respondents changed methodical approaches to their work and used special instrumentation, if customer's accounting was automated. 45% demonstrated a low level of response to such form of accounting, by adding a few special procedures and 12.5% of respondents did not react on differences of verifying "paper" and "electronic" accounting system of customer [7, 18].

The community of Nigerian professional auditors carried out the assessment of affecting the level of audit risk by automated accounting system. The results of the study are presented in the work of Prof. Ezendu Ariwa (the University of Bedfordshire, Great Britain) [8]. Outgoing information for the research was generated according to the results of processing special questionnaires, which revealed gaps in competences of Nigerian auditors and insufficient level of awareness of the issues, problems and risks arising at audit in the environment of electronic accounting data processing.

Detailed study of the effect of electronic environment risk factors of data processing on expert examination of financial institutions is being conducted by Asian scientists, headed by Shih Kuang-Hsun [9]. The integration of formalized data concerning current external environmental conditions of information management system in special products and decision making systems DEMATEL and ANP (Analytic Network Process) enabled them to single out six major risk components, forming 50.89% of its total level index.

Recognizing all traditional components of audit risk multiplicative model Pirvut V. insists on its expanding taking into account the specifics of generating and processing economic information in computing environment [10]. A new model component – "the risk of computer information systems".

On the whole, assessing the existing studies positively, it should be mentioned that they are aimed at detecting and confirming factors that indicate at high probability of data manipulation in computing environment, however, searching the effective methods of audit risk assessment in such environment is not finished.

3 The Aim

The aim of the study is to substantiate the needs and formalize the procedures of expanding the components of traditional multiplicative model of audit risk assessment

in computer systems processing accounting data of audit's client to reduce the level of information risk for financial reporting users.

In order to achieve the set goal the following tasks have to be solved:

- to analyze critically the most used multiplicative model of risk assessment in audit practice in terms of expanding its components, taking into account the specifics of functioning client's automated accounting systems;
- to develop the algorithm of audit risk assessment in electronic environment by extended multiplicative model;
- to work out approaches to constructing simple software instrument for testing formalized approaches to risk assessment;
- to reveal the possibilities of express analyzing risk indicators of accounting data distortion by using mathematical-statistical methods for processing large amounts;
- to conduct testing of the proposed model with interpretation of obtained results and evaluation of application possibilities in general audit practice.

4 Research Methodology. Modification of Audit Risk Assessment Methodology in Computing Environment of Data Processing and Using the Methods of Statements' Intellectual Analysis in Audit

4.1 Substantiating Requirements of Modifying Classical Model of Audit Risk Assessment

The theoretical part of the work hypothesis of this study is formulated in the following way: under information uncertainty of financial reporting users at enterprises with automated accounting classical multiplicative model of audit risk assessment cannot be completely relevant. It needs to be extended and to overcome subjectivism of auditor's opinion (expressed in descriptive form) must be expressed in easily interpreted numeric values (formalized).

In general, formalization is understood as methods that make it possible to present the studied object reflected in the form of signs of some artificial system (mathematics, radio engineering, programming, etc.).

Methodological aspects of the conducted study can be presented step by step:

- 1) studying audit risk factors in computing environment of processing client's data by using general scientific methods of cognition – analysis and synthesis;
- 2) constructing the model of audit risk assessment in the environment of client's automated accounting as image, which reveals in formalized form interdependencies and connections between various components of extended traditional multiplicative model;
- 3) developing approaches to constructing software product of detection risk assessment provided the client uses automated accounting products.

Auditor's practice revealed that risks connected with technical aspects of maintenance (the compatibility of hardware and software characteristics, uninterrupted operation of equipment, the using of illegal or non-specialized software by client) and procedures of special testing electronic data processing systems by auditor (the risk of incorrect construction and erroneous interpretation of tests by auditor because of his (her) insufficient skills in information systems and technologies) do not fit in a multiplicative model of audit risk.

So, these components should be singled out separately. Then multiplicative model of audit risk assessment can be represented as follows:

$$AR = IR * CR * TARCASO * TRACASO * DR, \quad (1)$$

where: AR is total (overall) audit risk; IR - inherent risk; CR - control risk; TARCASO - the risk of technical aspects of computer accounting system operating by client; TRACASO - the risk of testing computer accounting system operating by auditor; DT - detection risk.

To apply the proposed model in professional practice it should be grounded using formalized approaches to audit risk assessment. The following interpretation of the model was considered for the final analysis:

$$DR = \frac{AR}{IR * CR * TARCASO * TRACASO} \quad (2)$$

Such approach is stipulated by direct dependence only on auditor of the level of detection risk as a direct consequence of work proposed by him (her) and it being conducted.

Modern risk assessment techniques used in practice are based on determining detection risk provided inherent risk and control risk are previously studied and the acceptable value of total audit risk is chosen.

The most common approach is approximate analytical assessment, without any formalization. The level of risk according to the results of such study is represented as "low", "average", and "high". The disadvantage of this approach to audit risk assessment is its subjectivity, which does not enable to determine maximally accurately the rational size of audit sample to conduct complete study in a short time.

A more justified approach to risk assessment is based on preparing test-questionnaire, in which both general information about client and the information about the state of affairs at enterprise and in industry is analyzed.

Each factor is given a certain number of marks from 0 to 5, and according to the results of testing inherent risk is defined by the formula:

$$100\% - (\text{in fact mark}/5) \quad (3)$$

The presented technique is more progressive than the previous one owing to using formalized approaches to audit risk assessment, but its drawback is the absence of determining the effect of each test item (factor) on the level of risk.

According to the third approach inherent risk assessment is conducted on the basis of questionnaires (test), in which the degree of each risk impact is detected.

Questionnaire is filled according to the results of questioning persons responsible for preparing statements at each enterprise in the branch; testing determines the level of risk according to separate response and in the whole branch.

Positive response in each of the sections is indicated by plus, response relative to the levels of risk is estimated by three- mark scoring system: low risk - 1 mark, average risk - 2 marks, high risk - 3 marks.

The methods proposed by the scholars are simple and convenient for practical application in audits, but they have some drawbacks. Factors with low expert marks of the impact importance are evaluated by the authors as having actual mark zero that is they are simply leveled. A number of ignored factors having a low mark of impact importance can give a cumulative effect together and significantly change the overall audit risk assessment.

Therefore, when assessing risk according to factors we consider it expedient to operate not with the levels of risk, but levels of confidence expressed in marks, so risk assessment will be:

$$R = 100 - LC, \quad (4)$$

where R is risk and LC–level of confidence.

As a starting point for developing the package of applied electronic tables to assess audit risk in the environment of computer accounting data processing of client the research algorithm of V.S. Rudnytsky [11] adapted to new conditions was used.

1. Conducting the questioning of experts (auditors, inspectors, accountants, etc.) aimed to determine the list of factors that can have a significant impact on traditional (IR – inherent risk, CR – control risk) and new proposed elements of the extended model (TARCASO – the risk of technical aspects of computer accounting system operating by client; TRACASO – the risk of testing computer accounting system operating by auditor). Linguistic and semantic coordination, connection of factors close in meaning in one factor and exclusion of doubling factors. Ranking of chosen factors by the number of experts' given votes and selecting the most important factors.
2. Conducting expert evaluation of each factor's validity in partial assessment models (in marks).
3. Making electronic work tables-questionnaires in Excel environment and programming mathematical calculations of detection risk. The scale of model components' values for interpreting obtained digital results by practicing auditors is also proposed.
4. Filling out work tables during audit of inspected object and calculating the actual value of all the model components provided the value of accepted overall audit risk is at the level of 5%, as recommended by foreign and Ukrainian audit practices.

At the first stage a group of 30 experts was selected including employees of three audit firms in the town of Poltava, lectures of four departments at the Faculty of Accounting and Finance at Poltava State Agrarian Academy, and also chief accountants of agricultural enterprises from different districts of Poltava region. Then, by the method of "brainstorming" a group of factors having the greatest effect on traditional and new proposed components of the multiplicative model of audit risk assessment was identified.

As a result, a package of work electronic tables for audit risk assessment in computing environment by extended multiplicative model was formed. The tables are based on combination of testing with scoring system estimation of factors.

The verification of the extended model and approbation of the package of electronic tables can be conducted on the basis of using indices of statistical, financial statements and other economic data of agricultural enterprises, which occupy leading positions in the regions of Ukraine in terms of land use management, the number of employees and sum total.

The package of electronic tables will consist of tab page "General information" (information about the client of audit, which at the same time, affect the indices of inherent risk) and five mathematically interrelated calculation supplements to substantiate digitally all components of the extended multiplicative model of audit risk assessment.

According to practical comments to the International Standards of Audit 530 "Audit sampling" and 500 "Audit evidence" the terminal threshold of inherent (internal) risk is 75% and control risk - 65% if procedures essentially related to the class of operations (account balance) are conducted to check account balance (class of operations) [12, 19–21]. This percentage is determined by practices depending on sufficiency and reliability of audit evidence obtained as a result of factual inspection procedures. Based on the positions of professional skepticism while designing models of audit risk assessment provided the client uses automated accounting it is expedient to apply the highest possible values of risk levels.

Investigating the essence of the risk of technical aspects of computer accounting system operating by client and the risk of testing client's automated accounting system by auditor gives the reason to extrapolate these new components of the model, by the method of analogies, the finite values of inherent risk and control risk - 0.75 and 0.65, respectively.

To test the reliability of scientific hypothesis concerning enhancing the level of audit risk provided the client has automated accounting system, 30 agricultural enterprises in Ukraine (Poltava region) were chosen.

To achieve probabilistic threshold the selection was carried out according to the following factors: similarity of soil-climatic conditions and close geographic location; comparable sizes of land use management; similar production specialization; inconsiderable deviations in indices of the size of material-technical base and the sum of balance sheet total.

Integrating the data from these 30 enterprises in the environment of developed electronic application program package of audit risk calculation it was found that the level of risk value calculated by the components excluding new ones for the model (the risk of technical aspects of computer accounting system operating by client and the risk of testing client's automated accounting system operating by auditor) in the given totality was on average 0.0321 less than on the condition of full value considering the effect of client's automated accounting on the probability of deviations in the system of his (her) accounting and reporting.

That is, the hypothesis that automation of client's accounting leads to increasing the level of audit risk and causes the need in increasing the size of audit sampling was confirmed.

We believe that the above presented technique can be used as a basic internal standard of audit practice.

4.2 The Empirical Approach to Selecting Methods of Intellectual Analysis in Audit

Thus, the empirical side of work hypothesis consists in the necessity of searching the most appropriate method of intellectual analysis in audit reports taking into account the following conditions:

- 1) calculation of audit risk according to the multiplicative model in its classical and extended form, aimed at detection risk calculation, provided the total risk level is not higher than 5%;
- 2) the size of audit sampling for study is directly correlated with detection risk;
- 3) values used in calculations have the signs of “instantaneous indices” by the current date, which can be modified under the influence of economic, social, and other factors. This means that a set of factors in calculation tables will vary under the effect of enterprise’s internal environment and the professional evidence of auditor;
- 4) information risk of financial statements’ users can also be reduced by applying express-analysis of “behavioral” risk by auditor – the impact of “human factor”, which is expressed in fraud and manipulation of accounting entries.

For rapid detecting non-standard actions of economic subject’s personnel engaged in accounting, mathematical-statistical methods of intellectual analysis should be applied in the volume of accounting data, which is large and complicated for structuring.

1. Benford’s distribution [13, 14]. The most effective algorithm of using distribution is successive conducting three tests with the set of accounting transactions: analysis of distributing the frequency of the first, second numerical gap, and the gap of the first two digits in pair. Then graphical expression of tests is compared with the schedule Benford’s distribution, illustrating the “natural” behavior of financial accounting data, and immediately deviation transactions will be detected containing the first, second or first pair of significant digits for more detailed analysis.
2. Correlation analysis of data amounts of weakly connected accounting systems [15]. Using the defined mathematical-statistical method is based on the hypothesis confirmed by scientists [13]: at improper correction of result indices in financial statements (for improving indices of property position analysis, financial results and the level of credit rating) the corresponding data of managerial accounting (e.g. decreasing cost, material capacity) are not corrected as they are generated by different services because there is a considerable number of stock items of finished products. In time dynamics such corrections are labor intensive and can lead to disruption of the production process.
3. Cluster analysis. Information element of accounting system (account balance, transaction sum, turnover on the account, etc.) will be risk indicator of accounting data distortion; this element is considerably different from standard ones for the studied

general totality of accounting information. This totality is divided into clusters by auditor in such a way that each separate element can belong exclusively to one of them, depending on the criteria used for selection. Critical analysis of audit research practice [16, 17] enables to come to the conclusion that “g-means” are the most suitable methodological instruments of accounting data cluster analysis as to establishing risk indicators.

5 Results and Discussion. Experimental Verification of Empirical Hypothesis

During experimental verification of the adequacy of the proposed model the following facts were revealed.

In Ukrainian agricultural enterprises’ reporting accounts receivable are often used as an instrument of its misstatement, unjustified raising assets costs and veiling the facts of stealing material and financial resources. Accounts receivable are in the external environment concerning enterprise as an integral economic link, and they are mediated by connections with external economic agents, diverting resources from economic circulation. Determining their real amount and documented justification of the grounds of their appearing requires additional procedures, which take much time and are not simple because of complications in business communication among business subjects of Ukraine, as a result of high value of “corruption perception index”. According to the data of the international organization Transparency International in 2018 Ukraine added two more points to the “index of corruption” and is at the same level with Mali, Malawi, and Liberia.

It is expedient to justify auditor’s actions to increase sample size and identify indicators of possible misstatements in reporting and simultaneously apply the authors’ extended model of audit risk calculation in the environment of client’s automated accounting by using multifactor correlation-regression analysis.

Creating multifactor model to detect illegal modifications of reporting by manipulations with accounts receivable was carried out by the following stages:

- choosing effective index (Y) - the sum of accounts receivable;
- selecting the most important factors under the influence of which effective index is formed (X1 - the sum of cash remaining in statements; X2 - audit risk of not detecting deviations in client’s automated accounting system, X3 - the sum of accounts payable as to settlements with budget (through connection with tax obligations from VAT in selling operations) X4 - income from selling, X5 - cost of sold products, goods, work, and services; X6 - other operational income);
- analyzing and primary processing of input information using application program package STATISTIKA Stat Plus;
- economic interpreting the obtained digital indices.

The indices of financial statements of previously selected and described 30 agrarian enterprises in Poltava region, Ukraine and the indices of detection risk level (audit risk),

provided the client used special software products of accounting automation, became information support for constructing multifactor model.

The work hypothesis of using correlation-regression analysis is the following: there is a close relationship between effective index (independent variable - the sum of accounts receivable) and factor indices (dependent variables X_1 – X_6), (i. e, changing the level of accounts receivable is considerably stipulated by a complex impact of changes' dynamics of the selected X factors). If the probability of close connections is confirmed, it will be possible to prognosticate the amounts of accounts receivable using the model.

While conducting audit, specialist by using the developed model, can predict with a high level of confidence (0.95) the amount of accounts receivable at each definite agrarian enterprise of Poltava region. If in practice the index of accounts receivable sum, taken from financial reporting, substantially deviates from that generated in the model, illegal misstatements in reporting as a result of manipulating accounting entries are possible. That is, this indicator has to be studied by auditor in more detail or even continuously. Accordingly, the final audit conclusion, of course, will not be positive, and further development of events may even lead to refusal of inspector in giving out the report.

Line 1. Linear regression. Line 2. Regression statistics. Line 3. R . Line 4. R -square. Line 5. Standardized R -square. Line 6. Standard error. Line 7. Total number of observations. Line 10. Dispersion analysis. Line 12. Regression. Line 13. Remainder. Line 16. Coefficient Standard error t -statistics Significance point (value). Line 17. Y -interception.

Thus, the multiple correlation coefficient for this totality $R = 0.9637$. This value illustrates close relationship between the level of accounts receivable sums and combined factors X_1 – X_6 (in case of value is at the level of 1, functional relationship between the studied signs is stated). That is, changing the sums of accounts receivable by 96.37% is stipulated by the combined influence of changes in the amount of money (X_1), the level of audit detection risk in automated accounting (X_2); accounts payable on settlements with the budget (X_3); income from selling (X_4), cost of sold products, goods, work and services (X_5); other operating income (X_6).

The significance of the regression equation and R coefficient is verified by the world recognized method using F -test (Fisher's variance ratio test). In the results window the estimated (actual) value of F -test is $F = 49.9796$.

Tabular value of F -test for this complex of agrarian enterprises in Poltava region was chosen provided that $\alpha = 0.05$, and the number of freedom degrees equals $30 - 6 - 1 = 23$ where 30 is the quantity of sampling, and 6 is the number of dependent variables.

$F_{\text{tabular}} = 2.527655$. So, $F_{\text{actual}} (\text{calculated}) > F_{\text{tabular}}$, that is the zero hypothesis of the model insignificance is rejected. On the whole, the model and R coefficient with error level of 5% can be considered adequate.

The coefficients of the regression equation with dependent variables X_1 – X_6 indicate the extent and direction of changes in the effective index at changing the corresponding factor per unit (conditionally at complex ignoring the effect of all other dependent variables).

Practical significance of the obtained results for inspecting specialist is the ability to predict the value of reporting items, which by means of preliminary logical analysis are determined as such that can be a tool of manipulations and misstatements of financial

reports at agricultural enterprises. Thus, it was revealed in the studied model that 4 of 30 enterprises had significant deviations from predicted levels of accounts receivable. This was indicator of expediency for conducting additional audit verification procedures to provide the final audit report.

6 Conclusions

1. The necessity of comprehensive audit risk assessment is stipulated not only by local demands of internal and external users, but also the conditions of business processes globalization, institutional interaction of all participants in such processes, increasing information risk of reporting users who make business decisions based on these statements.
2. Modern information audit technologies, requiring the development of corresponding methods and algorithms for their importation and synchronization with corresponding software, must become the instruments of information accounting systems' audit.
3. Taking into account terminological variety of risk-oriented audit, the risks of audit activity have to be structured. In particular, the following classification characteristics should be considered: field of activity (information risk of financial statements' users, audit risk (professional), auditor's business risk) and subject (the risk of client's errors, the risk of making errors by auditor (detection risk).
4. The scenario of auditor's interaction with client's information accounting environment consists in using the extended multiplicative model of audit risk. It was proven that accounting automation of customer brings additional audit risks beyond basic multiplicative model of their assessment. The risk of technical aspects of the computer accounting system operating by client and the risk of testing computer data processing systems by auditor should be recognized as separate components of the model. The extended model requires to be substantiated by formalized approaches to audit risk assessment. As a result of calculations it was revealed that, if the impact of automated accounting system at 30 selected enterprises was taken into account, it increased the level of detection risk by the auditor by 0.0321 on the average.
5. Information risk of financial statements users can be reduced by auditor's using express analysis of indicators of possible fraud and manipulation of accounting entries. For their rapid detection in the massive and complex accounting data amount it is reasonable to use mathematical-statistical methods of intellectual analysis.
6. The results of testing multifactor correlation-regression analysis enabled to reveal a number of enterprises of 30 studied, in which the sums of accounts receivable were indicators of high detection risk of manipulations and financial misstatements.

Practical significance of the methodology, proposed by the authors, is the possibility to use intellectual analysis in auditing of both many objects and a single one. Not only accounts receivable but also other indices of financial statements, causing uncertainty of auditor's opinion can become effective indicator. Having determined effective indicator (causing distrust), auditor selects a combination of factors affecting the opinion formation (based on the available statement indicators and the content of their respective business

operations). The proposed model can also be used for inspecting one enterprise under the condition of studying the level of efficiency and factor indices in the dynamics of 5–7 years.

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