

an expert. The obligation to check the scientific (the presence of general scientific provisions, theoretical foundations of a certain type of examination) and methodological (the use of a certified methodology registered in Register of expert research methods) reliability of expert research results.

**Key words:** forensic examination, expert testimony, admissibility, reliability, standards of USA, criminal procedure of Ukraine.

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**Julija Liodorova**  
**doctoral candidate in economics**  
**analyst, forensic accountant**

ORCID 0000-0002-9968-3790  
E-mail: [julija.liodorova@vp.gov.lv](mailto:julija.liodorova@vp.gov.lv)

*Economic Crime Combating Department of State Police of Latvia*

**Irina Voronova**  
**Dr. oec.**  
**Professor**

ORCID 0000-0001-5117-7111  
E-mail: [irina.voronova@rtu.lv](mailto:irina.voronova@rtu.lv)

*Department of Innovation and Business Management  
of Riga Technical University*

**Ruta Shneidera**  
**Dr. oec.**  
**Professor**

ORCID 0000-0003-0521-7471  
E-mail: [ruta.sneidera@lu.lv](mailto:ruta.sneidera@lu.lv)

*Faculty of Business, Management and Economics of University of Latvia*

## **ADVANCED FORENSIC METHODS TO DETECT FRAUD**

The aim of the article is to study forensic accounting methods to detect fraud in financial statements. A taxonomy of forensic analytics methods is proposed and a generalization of seven mathematical models for detecting fraud recommended by forensic accounting experts and practitioners is provided, allowing for the detection of fraudulent financial statements before it is too late. The authors' qualitative analysis of evaluating fraud detection models is based on data from semi-

structured interviews conducted in the focus group of forensic accountants, investigators, and prosecutors.

**Key words:** forensic accounting, forensic method, fraud in financial statements, models

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The basic method of forensic accounting for fraud detection is already known – it is comparison and identification of inconsistencies with rules, facts, analogues (comparison of financial indicators based on average statistical data, by industry, similar enterprises, etc.). These forensic methods are mainly used to detect asset theft of related crimes – asset concealment. The main method for detecting these crimes is a normative approach which includes the mathematical recalculation based on the double-entry accounting method.

In today's world, the types of economic crime evidenced by accounting documents have changed significantly. The main economic crimes include fraud, tax evasion, bankruptcy fraud, and money laundering on the basis of forged documents, justifying a specific transaction (a contract or an invoice) or the company's activities as a whole. As a result, new technologies have been developed to detect fraud as crime patterns and methods evolve, as well as by observing the characteristics of criminal behaviour and the crime typologies.

According to Huber and DuGabriele [13], there is no emergency fraud, there is a new expression of old frauds. The known forensic accounting methods, including comparison, are applied to new and old frauds. The approach to the method is changing from manual calculation to advanced techniques. Analytical models developed by researchers help to detect poor quality income and outright fraud. Thus, forensic accounting research must support the profession providing practitioners with new methods or theories.

Fraud is a theft by deception. It involves all the different ways of using trickery to get another person's or organization's assets. No definite and invariable rule can be laid down as a general proposition in defining fraud, as it includes surprise, trickery, cunning, and unfair ways by which another is cheated [1; 24].

Frauds can be classified by the type of victim, the type of perpetrator, or the type of scheme. According to the Association of Fraud Examiners (ACFE), three major types of occupational fraud include corruption, asset misappropriation, and fraudulent statements. Frauds can be committed against and on behalf of the organization. Fraud that is committed on behalf of the organization is a form of management fraud or financial statement fraud [1; 2].

Fraud investigations can be classified according to the types of evidence produced or according to the elements of fraud. Fraud investigations include measures to determine who, why, when, and how much is involved. The fraud investigation identifies the perpetrators, the amounts seized, and the distribution of controls or other elements that allowed the fraud to occur [1].

There are some international analytical methods for detecting and proving fraud, which are also used in Latvia. These methods can be conventionally divided into three groups (see Table 1).

Table 1

## Taxonomy of forensic analytic methods

Summary of official facts	Methods based on expert competence	Economic-mathematical methods
Cash flow analysis	Principles or cases-based	Financial analysis
Net worth	"Red flags"	Mathematical models
Accounting methods	"Fraud triangle"	Benford's law
Matching & comparison	Expert assessments	Business analysis

Source: created by the authors based on the [1; 2; 18]

**Summary of official facts** on the basis of officially approved data of the institutions, which are direct evidence themselves – bank statements, State Revenue Office data on personal income, annual reports of companies, especially if their reliability has been confirmed by the examination of sworn auditors. These methods can be considered:

– Cash flow analysis allows identifying the origin of funds, payers, and justifications for payments; track the path of monetary transactions, including mergers and roundabouts. Cash flow can be determined not only on the basis of bank statements, but also on the basis of financial statements [18, p. 83–118].

– Net worth makes it possible to track the excess of a person's expenses over their income on the basis of declarations and other data obtained by the State Revenue Service. Some cost data can be obtained from official sources, such as Statistics Office, etc. [1, p. 261–273].

– Accounting methods help to determine the relationship between assets and debts, assess the company's results from economic activities, as well as track the movement of assets and calculate its value [21].

– Matching and comparison method reveals common characteristics and differences of compared objects contained in different documents to determine the identity of the corresponding indicators or discrepancies between them [21, p. 107].

Analytical methods, the results of which are **based on expert competence**:

– Principles or cases-based methods are the guidelines developed by professionals. For example, the International Audit Standard No.240 "The auditor's responsibility to consider fraud in an audit of financial statements" is designed for protect investors from fraudulent accounting activities by corporations [14]. The Association of Fraud Examiners (ACFE) has developed the complete classification of occupational fraud, often referred to as the "Fraud Tree" [2]. In 2020, the Financial Intelligence Unit of Latvia has developed a list of typologies to investigate money laundering based on a set of indicators [11].

– "Red Flags" as a warning that there is a potential threat. This method is widely used in auditing and is intended to detect changes in anomalous trends or atypical transactions that are not specific to the company's or individual's

behaviour. Red flags to detect internal fraud is presented by the Chartered Institute of Management Accountants (CIMA) [6]; red flags of fraud in public procurement are described by the European Commission European Anti-Fraud Office [9].

– “Fraud Triangle” is a model for explaining the factors that cause someone to commit occupational fraud. It consists of three components which, together, lead to fraudulent behaviour: perceived unshareable financial need, perceived opportunity and rationalization [2]. The fraud triangle is recommended to use by the European Commission for the timely prevention and detection of fraud related to the receipt of funds from the European Union [10].

– Expert assessments, the main of which are the assessment of economic activity, creditworthiness, and solvency of the company in connection with possible fraud in financial statements. Other tasks may include the business evaluating in a division dispute, calculating loss of profit in disputes arising from breach of contract [1, p. 565–581]. These methods are not yet popular with Latvian forensic experts. On the other hand, the method of lost profit calculation is used and presented by forensic experts in Lithuania [5].

**Economic-mathematical methods** based on scientifically tested theories, allowing the results of information analysis to be quantified, thus reducing the expert’s assessment of subjective facts. These methods are:

– Financial analysis includes the analysis of changes in financial data over time, either in structure, or in comparison with an analogue (compliance with the requirements of regulatory enactments, similar to the company). This could be a vertical and horizontal analysis, analysis of ratio – profitability, solvency, liquidity and activity, and others [18, p. 19–79].

– Mathematical models are the next development phase of the financial analysis method. The essence of the method is that a separate indicator is not assessed, but is assessed comprehensively – in the model. Examples are credit rating assessment, bank customer risk assessment. This method is used by the State Revenue Service in Latvia to assess the risk of tax evasion, and the results are available to the taxpayer: the taxpayer risk percentage is indicated by an arrow on the colour scale (“speedometer”), which shows the highest risk of tax evasion in red and the lowest risk in green [23].

– Benford’s law is a digital analysis technique that identifies the trend of the digits of numbers developed by F. Benford in 1938 [18, p. 237–292]. The method allows identifying atypical transactions in a large data array and it is the basis for the new generation tool “Data mining”, based on M. Nigrini’s research from 1996 [19].

– Business analysis methods allow modelling and analysis of crime as a “business”). An example is the PESTEL method used by the European Police Office (EUROPOL) to assess the threat of serious and organized crime (SOCTA) [7]. The business model CANVAS is a strategic management and entrepreneurial tool. It provides a more systematic approach to understanding criminality and allows analysing and identifying relationships and processes to assist effective interdiction [3].

The choice of method depends on the purpose of the examination, the research objects available, and the expert’s knowledge of the method.

Thanks to technological developments and availability of data, the use of mathematical methods and their verification has become more accessible. The **mathematical models** can quickly detect possible fraud in financial statements for rational decision-making on the choice of further investigation methods, as well as for planning forensic accounting examination stages.

The development of models that detect financial fraud dates back to the 1960s, replacing the basic method of financial statements analysis based on the descriptive analysis and assessment of financial ratios.

According to the literature review by M. Lenard and P. Alam [16], the problem of detecting fraud in financial statements was initiated in the late 1930s. By the 1950s, statistical techniques were used in auditing. Altman was one of the first to publish the study on the use of statistical model to predict bankruptcy in 1968, as bankruptcy and fraud detection was closely related. In 1980, instead of Altman's Z-score model, Ohlson developed his own probability model. In the early 1990s, models began to be developed to detect outright fraud, not just bankruptcy. Thus, in 1995, Persons published his logistic regression model to identify factors associated with fraudulent financial statements. In 1999, M. Beneish published his M-score model to detect earnings manipulation that become one of the most popular models for detecting fraud in financial statements.

In the 2000s, the requirements for auditors to detect fraud were enhanced the Statement on Auditing Standard (SAS) No. 82 (1997), revised SAS No. 99 (2002), adopting the Sarbanes-Oxley legislation, and the International Audit Standard (ISA) No. 240 (2003). This, as well as the developing of computer science, has led for the rapid development of a number of models, including those based on artificial intelligence or machine learning methods.

The trend of recent years is testing and adapting the developed foreign models to local conditions. In this context, the fraud detection model developed in 2015 by Lithuanian colleagues R. Kanapeckiene and Z. Grundiene should be noted [15].

In 2018, the State Revenue Service of Latvia developed the taxpayer rating system [23] so that taxpayers could see themselves through the eyes of the State Revenue Service of Latvia. Initially, the taxpayer rating was assessed by a 5-way analysis, which were expanded to 7 dimensions in 2020: registration data, reporting discipline, tax debt, auditing results, wage and business indicators, risks.

A historical overview of the development of fraud detection methods is shown in Figure 1 based on the [16, 18, 15, 23].

The figure shows that there are different methods and different classes of models for detecting fraud. Thus, there are simple models based on the score of indicators; accrual-based models that measure the impact of accruals in financial statements; models based on the discriminant analysis and logistic regression. The authors note that not all methods and developed models for fraud detection are shown in the figure, as there are many more. Some models show a certain value for the likelihood of fraud, other indicate red flags that require extended investigation.

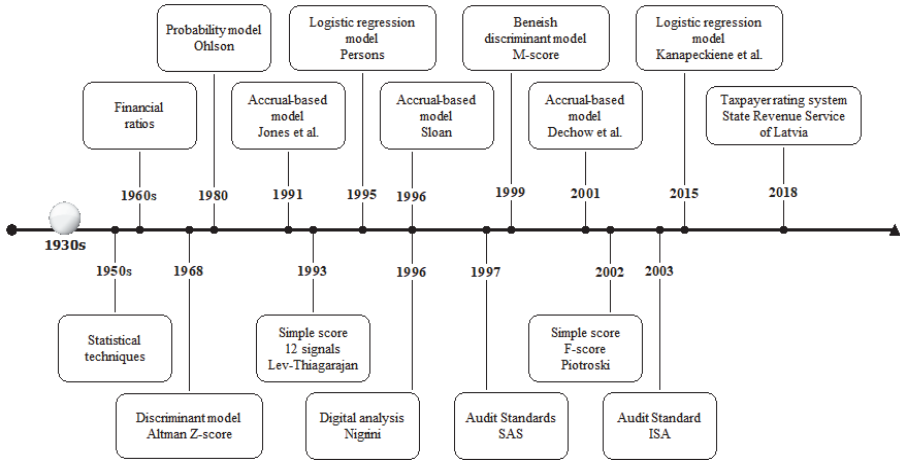


Fig. 1. Timeline of the development of fraud detection methods

The authors cover the mathematical models of fraud detection that are recommended for use in accounting forensics, adding new knowledgeable model developed in Lithuania. A summary of the models is presented in Table 2.

Table 2

**A summary of fraud detection models recommended to forensic experts**

Author, Year	Model description	Indicators included	Fraud assessment
Jones, 1991 [12]	Nondiscretionary accruals in assets to order calculate discretionary accruals used to manipulate earnings	3 indicators	Percentage of discretionary accruals to manipulate
Sloan, 1996 [22]	Accruals of implied cash component of earnings based on accruals impact to net income	3 indicators	Business with high accruals is inferior to business with low accruals
Dechow-Dichev, 2001 [8]	The quality of accruals based on realized cashflow for future periods	3 indicators	Lower accrual quality means that accruals are unrelated to future cash flows
Piotroski, 2002 [20]	F-score to indicate possible manipulation of financial statements	9 indicators	Scores – manipulation signals, F-score is total of scores

Lev-Thiagarajan, 1993 [17]	12 signals to measure earnings quality and future growth	12 indicators	Larger negative scores imply a low quality of earnings
Beinisch, 1999 [4]	M-score to detect earnings manipulation capturing financial statement anomalies	8 indicators	M-score is greater than -2.22 suggests a higher probability of manipulation
Kanapeckiene & Grundiene, 2015 [15]	Fraud detection model to identify fraud in financial statements	4 indicators	The likelihood of possible fraud expressed 0–100%

Source: created by the authors based on the [18, 15]

Pamela S. Mantone, a member of the American Institute of Certified Public Accountants (AICPA), a Certified in Financial Forensics (CFF) champion, a member of the Association of Certified Fraud Examiners (ACFE) Advisory Council, in her book “Using Analytics to Detect Possible Fraud. Tools and Techniques” presented the practical use of these models on examples of four companies. She notes that in some respects the models show an identical result for possible fraud, thus recommending the use of several methods in the examination [18].

In order to assess the feasibility of practical use of models for detecting fraud in litigation and forensic examinations, the authors conducted a focus group interview with forensic accountants, investigators, and prosecutors. The purpose of the interview: to find out the attitude towards the use of mathematical models for fraud detection in the process of investigating economic crimes and forensic accounting examinations.

The following issues were discussed during the interview:

- Do you know fraud detection methods in financial statements? Which ones? What methods do you use?
- Do you know the fraud detection models listed in Table 2?
- How do you assess the use of mathematical models in the investigation of economic crimes and forensic examinations? How could they be used?
- Do you know the taxpayer rating system developed by the State Revenue Service? (If the answer was no, the respondent was introduced to this system). How do you assess this system? Did you trust the results of this model?
- Would you have more confidence in the model if it was developed by a government agency? Your refusal if a similar model is developed abroad?

The respondents have little knowledge of the models discussed in the article; forensic accountants have heard about some models only from theory, since in practice they do not use them. The examinations use classic forensic accounting methods, such as accounting methods, matching and comparison, cash flow and financial analysis, and the system of “red flags”.

All respondents heard about the taxpayer rating system developed by the State Revenue Service. The respondents rate this system as easy to understand.

The investigators noted in particular the visualization of the transcript for each item of analysis on which the overall score is based. None of the respondents has any doubts about the reliability of the results, since *“there is no reason not to believe in the methodology of the state specialized organization”*.

In general, the respondents do not object to the use of models in both the investigation of economic crimes and in the performance of forensic accounting examinations. On the other hand, investigators and prosecutors are not ready to use models because they do not have enough knowledge in accounting and economics to make calculations according to the model formula. The youngest do not mind using models if the calculations were automated and their results could be clearly interpreted. The forensic accountants are not afraid of calculations, but agree that before using a model, it must be carefully analysed and tested in practice.

Forensic accountants: *“the models can help to obtain initial information (find an opinion) about a company, but cannot be used as evidence of fraud”*.

The investigators: *“the models such as taxpayer rating can be used to gain insight into a company and its potential fraud risks that should be examined first”*. The investigators and prosecutors do not believe that the results of the model cannot serve as evidence in a crime: *“the result of a mathematical model that can be trusted is a fact, but the evidence consists of a set of facts. If this fact does not contradict other circumstances and facts, but forms a unified picture, it can serve as evidence of a crime”*.

All respondents would trust the models developed by national government agencies. However, opinions differ on the development of models that could be used in the examination:

– Investigators and prosecutors have no opinion on this, as they hope that the expert will choose the best method himself: *“The expert does not invent methods from scratch, but is based on some scientific theories. He is a specialist in this field”*.

– Some of forensic accountants: *“The fact that the model is developed by national or foreign specialists will not change my attitude towards the model, the main thing is to determine precisely the criteria that can indicate the fraud of companies”*.

– Other forensic accountants: *“Foreign models have less reliable because they do not take into account local legislation and other national specificities. They must be tested and adapted to local conditions”*.

The authors' study leads to the conclusion that there are different forensic accounting models to detect fraud in financial statements. The models differ on number of indicators included, the criteria of evaluation.

The result of the interview showed, the respondents do not object to the use of models in both the investigation of economic crimes and in the performance of forensic accounting examinations. However, investigators and prosecutors are not ready to use models because they do not have enough knowledge in accounting and economics to make calculations according to the model formula. This means that targeted educational work is needed to promote using the models to detect fraud in financial statements.



Making a conclusion from the stated facts, we can state that it is necessary to develop new methods and techniques in the investigation of economic crimes. In turn, the application of the results of these methods as evidence of crimes requires verification of their quality for applicability to local conditions.

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## ПЕРЕДОВІ МЕТОДИ СУДОВОЇ ЕКСПЕРТИЗИ ДЛЯ ВИЯВЛЕННЯ ШАХРАЙСТВА

Ю. Г. Ліодорова  
І. С. Воронова  
Р. Шнейдере

Робота авторів присвячена дослідженню міжнародних аналітичних методів для виявлення і доказу шахрайства в ході розслідувань економічних злочинів і проведенні судово-бухгалтерської експертизи. Оскільки в якості загального положення для визначення шахрайства не може бути покладено незмінне правило, остільки і методи для дослідження продовжують активно розвиватися. Автори наводять характеристику трьох груп методів судової аналітики, які також використовуються в Латвії: методи узагальнення офіційних фактів на основі офіційно затверджених даних установ, аналітичні методи, засновані на компетенції експерта, і економіко-математичні методи.

Хронологія еволюції розвитку методів виявлення шахрайства проведена на основі історичного огляду. Наводиться опис математичних моделей виявлення шахрайства, рекомендованих для використання в судових бухгалтерських експертизах, з додаванням логістичної моделі, розробленої в Литві. Останнім етапом дослідження є неструктуроване інтерв'ю фокус групи з експертами-бухгалтерами, слідчими і прокурорами з метою з'ясувати ставлення і оцінити можливість практичного використання моделей для виявлення шахрайства в судових процесах та судово-бухгалтерських експертизах. Результат інтерв'ю показав, що респонденти не заперечують проти використання моделей як при розслідуванні економічних злочинів, так і при проведенні судово-бухгалтерських експертиз. Учасники опитування відзначили в якому напрямку слід удосконалювати дані методи для їх застосування в діловодстві.

**Ключові слова:** судово-медичний облік, криміналістичний метод, шахрайство у фінансовій звітності, моделі.

## **ПЕРЕДОВЫЕ МЕТОДЫ СУДЕБНОЙ ЭКСПЕРТИЗЫ ДЛЯ ОБНАРУЖЕНИЯ МОШЕННИЧЕСТВА**

**Ю. Г. Лиодорова  
И. С. Воронова  
Р. Шнейдере**

Работа авторов посвящена исследованию международных аналитических методов для обнаружения и доказательства мошенничества в ходе расследований экономических преступлений и проведении судебно-бухгалтерской экспертизы. Поскольку в качестве общего положения для определения мошенничества не может быть положено неизменное правило, постольку и методы для исследования продолжают активно развиваться. Авторы приводят характеристику трех групп методов судебной аналитики, которые также используются в Латвии: методы обобщения официальных фактов на основе официально утвержденных данных учреждений, аналитические методы, основанные на компетенции эксперта, и экономико-математические методы. Хронология эволюции развития методов обнаружения мошенничества проведена на основе исторического обзора. Приводится описание математических моделей обнаружения мошенничества, рекомендуемых для использования в судебных бухгалтерских экспертизах, с добавлением логистической модели, разработанной в Литве. Последним этапом исследования является неструктурированное интервью фокус группы с экспертами-бухгалтерами, следователями и прокурорами с целью выяснить отношение и оценить возможность практического использования моделей для выявления мошенничества в судебных процессах и судебно-бухгалтерских экспертизах. Результат интервью показал, что респонденты не возражают против использования моделей как при расследовании экономических преступлений, так и при проведении судебно-бухгалтерских экспертиз. Участники опроса отметили в каком направлении следует совершенствовать данные методы для их применения в делопроизводствах.

**Ключевые слова:** судебно-медицинский учет, криминалистический метод, мошенничество в финансовой отчетности, модели.