DETECTING FRAUDULENT FINANCIAL STATEMENTS BY USING CONTINUOUS AUDITING

Charalambos Spathis

Department of Economics
Division of Business Administration
Aristotle University of Thessaloniki

Abstract

Fraudulent Financial Statements (FFS) involve the manipulation of financial accounts by overstating assets, sales and profit, or understating liabilities, expenses, or losses. The aim of this study is to propose a framework combining Accounting Information Systems (AIS) and Intelligent Systems (IS) for Continuous Auditing (CA) with the aim of detecting FFS. AIS are a unified structure with an entity, such as a business firm, that employs physical resources and other components to transform economic data into accounting information. An IS consists of computer software designed to perceive, reason and comprehend. As both an expert and artificial intelligence system, the IS extends the computer's ability to process mass data in order to make decisions as a human would. In this study, we propose an intelligent approach that can test all or certain types of transactions or controls and ensure propriety of data. Acting like a detective control or analytical procedure, the system notes down control violations or unusual activities for further follow-up. Analytical tests then follow - namely evaluations of financial information made by studying plausible relationships among financial and non-financial data - to assess whether the account balances appear reasonable.

Introduction

One of the most promising fields of application for computers and their related technology is the financial field (Simon, 1991; Nelke, 2000). Over the last four decades, computer systems have grown exponentially. Their use and sophistication has permeated all business operations. However, the development of online control systems, and the auditing of these systems, has progressed very slowly. Real time sampling systems and embedded monitoring modules have lagged even more. The current audit approach primarily confirms information previously processed and distributed. Nowadays, the speed of business calls for the control analysis to be performed as part of the production cycle, and not at a later date. A move to more continuous and real time controls and their analysis would be of major benefit to numerous companies. The current backward looking audit model may need to be completely revised. There has been considerable progress in the use of computer systems to audit data. In addition, there have been major improvements in the use of technology for the management of the audit process. Examples of automation use in audit work processing include automated work papers, spreadsheets, and word processors. Data retrieval software, analysis, statistical sampling and other audit packages have all played an important role. However, some difficulties still lay in the path of online and continuous auditing processes (The Institute of Internal Auditors).

The aim of this study is to propose a framework combining Accounting Information Systems (AIS) and Intelligent Systems (IS) for Continuous Auditing (CA) with a focus on the detection of fraudulent financial statements (FFS). The detection of FFS is based on previous empirical findings specific for Greece (Spathis 2002; Spathis *et al.*, 2002) related to the analysis of audit reports (Spathis 2003; Spathis *et al.*, 2003). AIS are a unified structure with an entity, such as a business firm, that employs physical resources and other components to transform economic data into accounting information (Wilkinson *et al.*, 2000). An IS consists of

computer software designed to perceive, reason and comprehend. As both an expert and artificial intelligence system, the IS extends the computer's ability to process mass data in order to make decisions as a human would. CA is defined as: "a methodology that enables independent auditors to provide written assurance on a subject matter, for which an entity's management is responsible, using a series of auditors' reports issued virtually simultaneously with, or a short period of time after, the occurrence of events underlying the subject matter" (AICPA, 1999).

Following the works of Groomer and Murthy (1989), Vasarhelyi and Halper (1991), and Vasarhelyi (1998; 2002) on CA, this study proposes an intelligent approach that can test all or certain types of transactions or controls to ensure propriety of data. Acting like a detective control or analytical procedure, the system notes down control violations or unusual activities for further follow-up. Analytical tests then follow - namely evaluations of financial information made by studying plausible relationships among financial and non-financial data - to assess whether the account balances appear reasonable.

The remainder of this paper is organised as follows: The next section reviews previous research on FFS, continuous auditing and intelligent systems. A framework for detecting FFS is proposed and the final section provides the concluding remarks.

Fraudulent financial statements

Fraudulent financial statements (FFS) are increasingly frequent over the last few years. FFS primarily involve the manipulation of data by overstating assets, sales and profit, or understating liabilities, expenses, or losses. When a financial statement contains falsifications, so that its elements no longer represent the true picture, we speak of fraud. Management fraud can be defined as deliberate fraud committed by management that injures investors and creditors through misleading financial statements. The type of fraud addressed in this paper is financial statement fraud: the in-

tentional misstatements or omissions of amounts or disclosures in financial statements (AICPA 1977).

Spathis *et al.,* (2002) used the UTADIS multicriteria decision aid classification method to address the identification of firms issuing FFS. Ten financial ratios were selected for examination as potential predictors of FFS. These variables appeared to be important in prior research and constitute ratios derived from published financial statements. The variables selected by the above techniques as possible indicators of FFS are: the ratio of total debt to total assets, the inventories to sales ratio, the net profit to sales ratio and the sales to total assets ratio. The conducted analysis suggests that there is strong potential in detecting FFS through the examination of publicly available financial statements. The study's results, along with the comparison with well-established statistical classification procedures, support future use of multicriteria analysis as a fraud-risk assessment tool.

Spathis *et al.,* (2003) developed a model that identifies factors associated with qualified audit reports and predicts whether firms will receive qualified or clean reports. Univariate tests were employed to select the appropriate explanatory variables and a multicretiria decision aid classification method (UTADIS) was used. Ten variables (eight financial ratios, one dummy variable and the z-score) were selected to analyze the qualified audit reports. These variables appeared to be important in prior research and constituted ratios derived from published financial statements. The variables selected by the above techniques as potentially useful indicators were: the receivables/sales ratio, the net profit/total assets ratio, the sales/total assets ratio and the working capital/total assets ratio. The UTADIS method was found quite effective in predicting qualified/clean reports, providing an estimated classification accuracy of approximately 80%. This result suggests that there is potential in identifying pre-engagement factors associated with qualified audit reports through the analysis of publicly available financial statements. The conclusions are thus encouraging in that we believe we have developed a reliable model for assessing the likelihood of identifying qualified audit reports issued by businesses in Greece. Use of the proposed meth-

odological framework could be of assistance to professionals who are interested in the financial prosperity of the firms they monitor. This study complements the earlier one on FFS detection, thus contributing to an integrated analysis of the accounting practice in Greece concerning the analysis of audit reports and the detection of FFS.

FFS are related to creative accounting in Greece. In a recent study by Baralexis (2004), it is stated that creative accounting is frequently practiced in Greece, with large companies overstating their profit, while small companies understate theirs.

Continuous auditing

Continuous auditing has been the subject of intensive discussions for at least twenty years (Kearns, 1980). Factors that long ago suggested that continuous auditing was an idea that required application include (Kearns, 1980): (a) Increased dependency on sophisticated information systems; (b) Greater volumes of data processed by these information systems; (c) Heightened management responsibility for adequate internal control, and (d) Development of audit tools that make continuous auditing viable.

These reasons are even more prevalent today than twenty years ago. Since continuous auditing has been suggested as a professional service for some time now, possible audit techniques have been discussed for use in a continuous auditing environment. Groomer and Murthy (1989) and Vasharhelyi and Halper (1991) have suggested possible techniques for auditing information in a more efficient and timely manner than the techniques used in an annual audit. With the continuing heightening trend of IT dependency, recommended techniques have focused on Computer Assisted Audit Techniques (CAATs) that allow the possibility of efficiently auditing certain types of data through the increasingly well-used network of database environments of many organizations. Some of these CAATs essentially involve embedding the analytical procedures within the network database of an organization.

Vasarhelyi and Halper (1991) described the Continuous Process Auditing System (CPAS) developed at AT&T Bell Labs for the internal audit organization, designed to deal with the problems of auditing large paperless real-time systems. They discussed the importance of the continuous auditing system and compared it to the traditional audit approach. The CPAS monitors key operational analytics, compares these with standards, and leads the auditor's attention to any problems that may exist. Ultimately, this technology utilizes system probes that monitor the system and intervene when necessary. Yu *et al.* (1998) placed CPAS in an electronic commerce framework, and evaluated possible impacts of electronic commerce on the overall auditing process. They developed security methods for electronic transactions and provided two new auditing process models (periodical auditing process and continuous auditing process).

In response to these numerous trends, both the Canadian Institute of Chartered Accountants (CICA's) Inter-Institute Vision Task Force and the Special Committee on Assurance Services (also known as the «Elliott Committee») have suggested that auditors move from annual audits to a more timely audit that would ultimately become continuous (CICA, 1996) (AICPA, 1997a). A number of traditional professional services already provide timelier reporting than the traditional annual audit. The reviews of quarterly financial results for SEC registrants are a traditional attestation service that is timelier than the annual audited financial statements. Some SEC registrants have reviews that take place each month. Many non-public companies have their financial statement data reviewed or compiled on a monthly basis.

Apart from the traditional compilations and reviews, new services that have recently been developed by the profession, such as WebTrust and SysTrust, provide timelier reporting of results than the traditional audit. Both of these services focus on IT, with WebTrust providing assurance for a 90-day period for Internet websites and SysTrust providing assurance for information systems at a particular point in time. Although they render timelier reporting of results than traditional audits, these services focus only on continuous auditing.

Differences between auditing and continuous auditing

When comparing the ASOBAC ("A Statement of Basic Auditing Concepts") definition of auditing to the AICPA/CICA definition of CA, two differences are observed. The first difference deals with the subject matter, while the second deals with the time of attestation. Beyond these two obvious differences, the method of investigation differs in a less evident manner. Continuous auditing specifically focuses on the primary use of network database technology for attesting the subject matter. The following sections provide an analysis of each individual difference.

(a) *Subject matter:* The AICPA / CICA definition of continuous auditing differs from the definition of auditing by providing an opinion not just on economic actions and events summarized in financial statement form, but on many other types of subject matter as well. While traditional annual audits are associated only with financial information, continuous auditing is concerned with the attestation of some financial statement information, as well as relevant non-financial information. This is in accordance with the profession's shift towards the provision of assurance services that attest many broader types of information.

(b) *Time frame of attestation:* The use of the word 'continuous' in the term "continuous attestation" represents the importance of timeliness in attesting relevant information. From the three qualitative characteristics of information (relevance, reliability and timeliness), relevance, along with reliability, are considered primary characteristics (FASB, 1980). In order for information to be relevant and influential in making decisions, it must be timely and have predictive and/or feedback value (FASB, 1980). Focusing on the timeliness aspect, if information is not provided in a timely manner, then it has reduced or no value for use in making decisions. Timeliness is essential for information to have value to decision-makers. The definition of auditing makes no specific mention as to the timeliness of investigating and reporting financial information. Traditional annual audits are necessarily concluded after year-end, with varying amounts

of procedures performed in the interim before the end of the fiscal year. As for reporting, annual financial statement audit reports are usually issued from one to three months after year-end.

(c) *Manner of investigation:* The proliferation of Information Technology (IT) is what allows continuous attestation to be discussed as a possible service rendered by the accounting profession. In fact, the word "online" has been used as a means of describing the notion of continuous auditing and reporting (Vasarhelyi, 1998).

Both Groomer and Murthy (1989) and Vasarhelyi and Halper (1991) suggest a number of techniques that may be feasibly used in a continuous attestation environment. One method, Embedded Audit Modules (EAMs), concerns programs within a database application that perform audit procedures concurrently with the processing of the application (Groomer and Murthy, 1989). EAMs can capture information of audit significance on a continuous basis regardless of the security and data integrity features of the Accounting Information System (AIS). Interfacing with the AIS, EAMs can test all or certain types of transactions or controls to ensure propriety of data. Acting like a detective control or analytical procedure, control violations or unusual activity can be noted for further follow-up or automatic system shutdown. EAMs are suited for use in auditing the activities of a routine transaction process (Groomer and Murthy, 1989) and are best implemented during the development of a network database system. If not integrated during the development and implementation of a system, the difficulty and expense of installing EAMs into a system could be enormous. A second method suggested by Groomer and Murthy (1989), as well as Vasarhelyi and Halper (1991), is the use of queries, such as through Data Description Language (DDL) or Data Control Language (DCL). This method makes use of the security and integrity features of the database system software itself.

The three main differences between auditing and COA (subject matter, frequency of assurance and manner of investigation) are a reflection of the business trends and needs of decision makers over the last two decades. Financial

statement users no longer rely primarily on annually audited financial statements as their main source of information when making decisions (Rimerman, 1990; Elliot, 1992). The accounting profession already provides attestation of quarterly information for stock exchange registrants, and information used to make decisions in a timelier manner than with audited financial statements. Many decision-makers, however, use un-audited information, whether financial or non-financial, provided on a timely basis and not at the end of year, audited financial statements or quarterly statements.

CA builds on the power of a firm's underlying enterprise resource planning (ERP) and other systems to produce audit results simultaneously with, or a short period of time after, the occurrence of relevant events. Spathis (2004) provides a detailed examination of the benefits to a firm's accounting process from the automation and integration capabilities of its ERP system. In comparison with the traditional financial statements audit, CA aims to be timelier, more comprehensive, more accurate and more supportive of the management process. While attaining that goal is still a work in progress, and the implementation of CA remains in its early phases, topical interest has clearly reached critical mass.

Continuous auditing and fraud

Regulators and users of financial information have often criticized the current traditional audit model for failing to detect fraud or other illegal acts and to identify appropriate risks. The recent financial crisis seems to support the stakeholders' criticism e.g., (a) alleged fraud in WorldCom, (b) alleged illegal acts in Tyco and (c) unknown risks incurred by Enron in structuring special-purpose entities (AICPA 1997). This crisis has led financial statement users and regulators to question the integrity of both auditors and corporate managers.

Vasarhelyi *et al.* (2002) queried whether continuous auditing would have uncovered the Enron issues before they escalated to a crisis. They noted that a continuous audit would (a) focus on all processes, including those that are not a component of the financial report; (b) be more akin to

a supervisory review than the traditional "after-the-fact" review; and (c) rely on analysis that crosses corporate business processes and address risks. Moreover, continuous auditing methodology expands traditional audit methodology by focusing on anomalies such as extraordinary transactions.

Rezaee *et al.* (2002) primarily focused on external auditors building continuous auditing capabilities through the use of audit data warehouses and data marts. Searcy *et al.* (2002) surveyed partners in the Big 4 firms to obtain their views on continuous auditing. The partners surveyed expressed their views on obstacles, the viability, the current state of continuous auditing and the potential impact that continuous auditing may have. The authors noted that continuous auditing may be required for external auditors of public companies and that without the commitment of audit clients to implement the technologies and make key financial information available, continuous auditing was not feasible. The partners' responses to the survey were: (a) capital markets will be expecting new reporting and audit models in the future; (b) discussions with clients on providing assurance on real-time reports has received little attention; and (c) most partners believed that continuous auditing of continuous reporting would increase users' expectations about auditors' ability/responsibility to (i) report going-concern problems in a more timely manner, (ii) detect fraud, and (iii) provide more assurance on the degree of reliability of financial information.

Intelligent systems

An Intelligent System (IS) consists of computer software designed to perceive, reason and comprehend. As both an expert and artificial intelligence system, the IS extends the computer's ability to process mass data in order to make decisions as a human would. However, new tools have also been discovered, such as Computational Intelligence (Langley and Simon, 1995). This tool has very often proven to be a valuable asset in the general field of decision-making and expert system modeling, which suggests that its implemen-

tation in relation to continuous online auditing could be highly successful. The idea is to extract the knowledge from the experts in a correct manner and then to create a system that will apply the knowledge to a set of continuously changing data.

Knowledge extraction

New technologies and methods have made the extraction of essential knowledge from the experts an easier and more efficient exercise. There are two main ways of collecting the information required to initialize any process involved in teaching a computer about the various aspects of decision-making. The first is to try and extract the knowledge directly from the experts. The second is to try and extract the knowledge from the experts' work.

As regards the first method, one can find many prescriptive models of audit approaches in evolving computerized systems (Davis and Weber, 1983; Wand and Weber, 1989; Wu and Hahn, 1989). Receiving the knowledge directly from the group of experts that have been assigned to deal with a certain problem is almost impossible. The reason being, that most of them are ignorant in terms of advanced computer knowledge, to the extent that they consider the personal computer as a vicious enemy, whose only purpose is to rob them of their position. As a result, they are very reluctant to share their knowledge when asked and, in some cases, they even refuse to discuss alternatives to their way of dealing with the problem in hand. Rules in the form of "if then, else" are programmed into the computer.

The whole process can be accelerated if questionnaires are sent to the experts by e-mail, asking them to judge a certain case and explain how they reached that specific decision. The answers can then be collected and screened in order to extract the rules. Other methods include the use of brainstorming techniques, group-sessions and interviews between the programmers and the experts. The selection of any of these techniques depends on the existing circumstances at the time of the system's development. Furthermore, the development team has to keep in mind that the developed system has to fulfill the control objectives of ac-

curacy, completeness, security, timeliness and recoverability of information, so as to be reliable (Chan, 1992; Gill and Gosserat, 1993).

The second way of creating the necessary database is to try and extract the knowledge from the experts' work. This methodology is preferable, since it avoids the constraints of the first method. Moreover, it also has some crucial advantages. The first is that, from the initial stage of the process, the data is translated into a form that the computer software recognizes, which means that an interactive learning process can be established. In other words, when new cases are presented, it is easy to incorporate them into the knowledge database. Another advantage is that the rules are automatically created in the form of decision trees; these can be very easily understood by the experts, who can then provide the implementation team with important feedback.

Available tools

There are various tools available for automatic knowledge extraction. The most common ones are based on information entropy, fuzzy sets, expert systems, neural networks or a combination of these methods (Spathis *et al.*, 2001).

(a) Information entropy: In the past decade, various types of information entropy software for the purpose of knowledge extraction have been introduced. This category of software has the advantage that its theory is based on mathematical models and statistics. It can manipulate both numerical and qualitative data with the same ease and, as an output, it presents a decision tree in a very comprehensible form. The basic advantage of the algorithm that it incorporates for data mining, is that it has the same capability of handling numerical as well as linguistic values, without requiring any transformation processes. Its main purpose is to construct a decision tree and/or extract a set of rules that will correctly classify new cases, according to the classes stated in the initial training database.

(b) Fuzzy logic: Many problems of a complex nature, however, cannot be handled through the use of information entropy. Thus, non-conventional methodologies have

been created to deal with such problems. Fuzzy logic is the first non-conventional technique used in industry for solving problems; it was presented by Zadeh in the mid 1980's (Zadeh, 1985; Zimmerman, 1996). As is well known, fuzzy logic is based on the assumption that the surrounding environment consists of data that belongs to different data sets with different degrees of membership. The complexity of this theory is the major cause for it not having been applied earlier in the field of industry. However, applications have shown that it is a strong tool in the hands of the expert, not only for the purpose of representing knowledge and experience, but also for creating conclusion extraction mechanisms that use the available encrypted knowledge and the current value of the attributes of the process under control to extract the required control actions.

(c) *Neural networks:* Another theory that is gaining more support is the theory of Neural Networks (Freeman, 1991; Kosko, 1992; Lin, 1994). The concept behind artificial neural networks is to imitate the structure and workings of the human brain by means of mathematical models. The foundations of most neural networks focus on three basic qualities of the human brain: knowledge is distributed over many neurons within the brain; neurons can communicate with one another; and the brain is adaptable. Neural networks (NNs) process data in a parallel processing mode. A neural network (NN) is a network of many interconnected processing elements that can process multiple operations simultaneously. This multiple processing capability enables NNs to execute operations much faster than traditional methods, which process data serially, one operation at a time. NNs solve problems by recognizing patterns in data that may be too subtle or complex for humans or other types of computer methods to discern. An NN creates a mathematical model from a database of historical examples of input and output values. The NN system automatically adjusts its analysis until it learns the most probable relationships between the inputs and outputs (Wilkinson *et al.*, 2000).

An NN is suited for simple to complex and structured to unstructured problems. Thus an NN can solve a much broader range of problems than an ES, including problems that are almost completely random in nature. Specific accounting applications suitable for development by using NN software are: (a) Detecting management fraud; (b) Detecting weaknesses in internal control structure; (c) Interpreting audit evidence; (d) Interpreting audit quality; (e) Detecting employee fraud; (f) Interpreting staff evaluations; (g) Predicting bankruptcy; (h) Predicting occurrence of risks.

The development and implementation of an accounting NN application is often much easier and faster than that of an accounting ES application. In addition, some NN software packages select the network structure automatically, making the developmental process much faster compared to other NN packages that do not offer this feature. The NN development process consists of creating a database of examples, constructing a mathematical model of the relationships detected in the data values, evaluating the performance of the derived network, and implementing the model for its intended purpose.

A neural network differs significantly from an Expert System (ES). An ES is developed based on knowledge extracted from an expert, whereas an NN derives its knowledge from examples of historical data. Moreover, an ES has a strong user interface and an explanation facility to establish the reasoning for its decisions; an NN does not provide these options. An NN is trained through the processing of examples of historical data. The network constructs a model by recognizing patterns or correlations in these data observations.

Expert systems

An expert system is a computerized software model that simulates the thinking process of one or more human experts in solving a complex problem or in making a decision. It utilizes a type of knowledge engineering to incorporate into a computer program the specialized knowledge and symbolic reasoning process of the human experts. As opposed to procedural programming languages, which solve

numeric problems, expert systems emulate the way experts manipulate symbolic or non-numeric information. Thus they are electronic consultants able to advise, analyze, train, diagnose, explain, and justify their conclusions to a non-expert user (Wilkinson *et al.*, 2000).

Numerous types of firms are rapidly adopting accounting and business expert systems. All of the Big 4 public accounting firms, not-for-profit firms, manufacturing firms, and numerous other types of firms are either using or developing accounting expert systems. High-payoff areas of expert systems by branch of accounting are: (a) Classifying financial transactions correctly; (b) Analyzing unusual transactions; (c) Analyzing the adequacy of the allowance for doubtful accounts; (d) Evaluating creditworthiness; (e) Issuing audit reports and forming audit opinions; (f) Assisting in making a going-concern judgment.

Within these, the majority of accounting expert systems are being used or developed in the audit and tax areas. A recent on-line search of accounting expert systems articles revealed that about 60 percent pertained to auditing and tax applications. A sample of real-world expert systems in the audit and tax areas include: (a) Auditor: To aid in evaluating the adequacy of the allowance for bad debts; (b) EDP-XPERT: To aid audit specialists in evaluating the reliability of controls in computer systems; (c) GC-X: To aid in making going-concern judgments; (d) Taxpayer Service: To aid IRS agents in answering taxpayer questions on complex tax issues.

Developing an expert system requires the services of experts, knowledge engineers, and users. As a rule, expert systems go through three major stages of development: (a) knowledge acquisition, (b) computer modelling and debugging, and (c) validation. The knowledge engineers first determine from the users the purposes and applications of the proposed expert system. Then they extract the relevant knowledge from the experts. Based on this knowledge, the knowledge engineers determine the rules of thumb the expert uses to make decisions in the problem area being programmed. Most accounting expert systems are developed using an expert system shell, that is, a commercial software

development package. An expert system must be proven reliable before non-experts use it to make real-world decisions. Validation —measured by the validity rate— is the process of determining and improving the reliability of an expert system. The validity rate is the percentage of correct answers that an expert system gives and corresponds to those of one or more human experts. The expert system's validity rate should be equal to or higher than the validity rate of its human counterparts.

A framework for detecting FFS

In the paragraphs above, there is a description of the tools available for the extraction of knowledge and hence of the control rules for carrying out the auditing process. If an expert system is realized either by means of information entropy, fuzzy logic, neural networks or a combination of these techniques, then we can proceed with the next phase of the proposed framework.

At this point it is imperative that a final evaluation of the expert system takes place. The main concern should focus on the following: (a) whether the system provides all the necessary data for the auditing, such as the timing, recognition, storage, retrieval, and review of financial transactions documentation, (b) whether it is accurate on its assessments, (c) whether it provides security and recoverability of information. If these demands are met, then the process of making the necessary alterations to the system in order to make continuous auditing should take place for the purposes of FFS detection.

At this phase, there are a small number of important steps that should be followed in order to reach the final outcome (Figure 1). The first is to establish a connection between the actual databases from which the expert system will take the data while being online. This means that, as each new case is presented, its data will be automatically accessed by the system and translated into the form that the expert system recognizes (when necessary). Most of the work at this level has been dealt with in the first phase, concerning knowledge

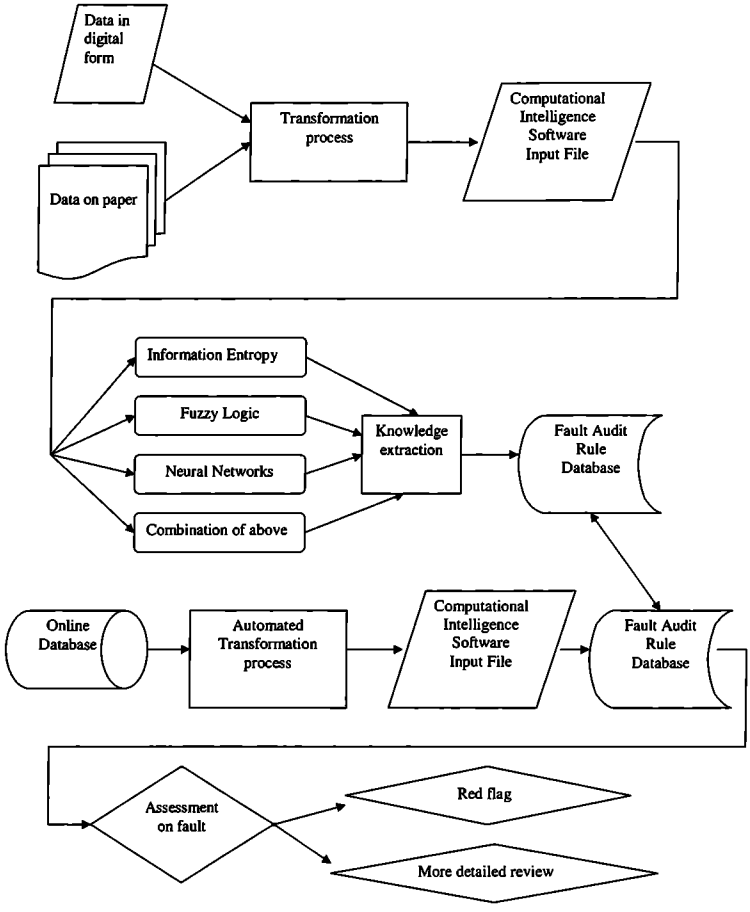

Figure 1. A framework for continuous auditing.

extraction. The auditor has to extract the knowledge from the expert and find the rules that apply for errors. In order to do this, the initial database should be transformed into a proper input database for the computational intelligence software that is going to be used. The software could be an implementation of information entropy, fuzzy sets, neural networks or a combination of these techniques. After the options have been set in the software, the supervised training can begin. That means that a group of experts will provide the appropriate training examples that are representative of that specific error category. This will be done for all of the error categories. The aim in this phase is to construct a fixed and complete error audit knowledge database that will be used in phase two as the dynamic auditor. Therefore, it is important that effective, reliable, quick and secure methods for translating the initial data into the proper form are found at the first phase.

In the second phase, these methods will provide the backbone for the automation of accessing real-time data. After the realization of automated accessing of the data, the expert system will give real-time assessment on the nature of the problem and any alteration or deletion of the initial data will take place. The goal is to link the extracted error audit knowledge database with the actual AIS database. The computational software will provide an assessment on each new case as to whether it incorporates errors or not, and if the probability is high or higher than the number given by the decision maker, then it will proceed to correct the error itself. If this is not feasible, it will mark the case for a more detailed review by the auditor. This technology will examine 100% of financial transactions, not just a sample in real time, comparing each one against a predetermined set of business rules.

At the end of each period (month, quarter or year), the ratios of the financial statements are calculated which, according to the FFS model, indicate likelihood of fraud. These ratios are compared with the respective values of the ratios included in the fault audit rule database. The expert system then classifies these financial statements as fraudulent financial statements (FFS) or non-FFS. Those classified as FFS are then further examined by the auditor.

Both of the software tools discussed, offer the necessary facilitations in order to make this a reality, which is the main reason why they were chosen from a variety of other programs. Such software as mentioned earlier has a freely distributed source code in C++, and so it is easy for a programmer to incorporate the extracted rule-base into a new application. DataEngine has an Application Development Library (ADL), which performs the integration of the extracted fault audit database and requires little programming effort. This ADL is available as C++ class library for various different platforms and compilers. Furthermore, under MS Windows, it is available in the form of Dynamic Link Library (DLL), which has a special interface for Visual Basic, Borland Pascal/Delphi and C++. Another task that has to be completed, after a small number of new cases have been added, is that the system should also take them into account when making an assessment on other new cases. This process should also be automated, when an actual implementation of a continuous auditing expert system is developed.

The auditors with suitable software will run auditing financial statements posted on Internet web sites, scanning and analysing the differences between existing trends in the company's reports. The above-mentioned software also identifies "red flags" that substantially differ from defined norms. The software implementation of the proposed methodology can be easily achieved without significant cost, by using any programming environment or commercially available linear programming packages. Furthermore, apart from data collection, Internet technology can also be used for the implementation of the proposed methodology at a low cost. The methodology can be implemented at the central level (on a server) and auditors can employ the proposed methodology via the Internet by inputting data through a spreadsheet interface and obtaining online estimations on the probability that a firm issues FFS. Such an implementation approach would be of interest to audit firms, where expert decision analysts will be responsible for model development at the central level and auditors will use the developed FFS detection models via the Internet.

Concluding remarks

The present study provides a framework for pursuing continuous auditing with the aim of detecting FFS. Through a brief survey of the software tools available, I have found two that both satisfy all the modern theories of machine learning and provide the necessary tools for taking the next step. After obtaining the above-mentioned software tools, one should try at an initial stage to find efficient ways of extracting the rule database. I believe that the first stage of the framework is the most important one, since everything is based on whether the generated expert system behaves well or is efficient at detecting the faults. If not, then there is no point in transforming it into a real-time system.

The use of the proposed methodological framework could be of assistance to auditors (both internal and external), taxation and other state authorities, institutional investors, the stock exchange, economic analysts, and to the banking system. For the auditing profession, which is taking measures to fulfill its responsibility regarding the detection of FFS, the results of this study could also prove beneficial. Assisted by this model, auditors can provide effective expert witness testimony and computer litigation support regarding FFS at a low cost to the auditing company.

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