

INTEGRATING ANALYTICAL PROCEDURES INTO THE CONTINUOUS AUDIT ENVIRONMENT

Eija Koskivaara

Turku School of Economics

ABSTRACT

The objective of this article is to show how to embed analytical procedures (AP) into the continuous audit environment. The audit environment is discussed in terms of audit phases, where the role of APs is to obtain evidence for auditors. The article addresses different characteristics of AP techniques. Furthermore, the article compares four different AP techniques to form expectations for the monthly sales values. Two of these techniques are simple quantitative ones, such as the previous year's value and the mean of the previous years' values. The advanced quantitative techniques are regression analysis and an artificial neural network (ANN)-based model. In a comparison of the prediction results, the regression analysis and ANN model turn out to be equally good. The development of these kinds of tools is crucial to the continuous audit environment, especially when most data transmission between companies and their stakeholders are moved into the electronic form.

Keywords: continuous auditing, analytical procedure techniques

Recebido em/*Manuscript first received:* 19/06/2006 Aprovado em/*Manuscript accepted:* 11/09/2006

Endereço para correspondência/ *Address for correspondence*

Eija Koskivaara, is currently an assistant professor in the Department of Management at the Turku School of Economics. She obtained her Master's and PhD degrees in economics and business administration, majoring in Information Systems Science, from the Turku School of Economics and Business Administration. Endereço: Rehtorinpellonkatu 3 FIN-20520, Turku Finland. E-mail: eija.koskivaara@tse.fi

1. INTRODUCTION

The idea of continuous auditing (CA) is not new (Kunkel 1974; Groomer & Murthy 1989; Vasarhelyi & Halper 1991), and many models have been suggested. But, most models have only been conceptual frameworks, although the real-time assurance services can assist in preventing unintentional or intentional errors. Kogan, Sudit, and Vasarhelyi (1999) in particular have determined that the development of continuous auditing tools is important in order to create a real on-line auditing environment in today's turbulent business world. Furthermore, the development of auditing tools is important with regard to the workload and demands of auditors in today's business environment.

The objective of this article is to show how to embed the analytical procedures (AP) into the continuous audit environment. The article proceeds as follows. Section 2 provides an overview of the continuous audit environment with APs integrated in it. Section 3 embeds APs into the audit phases. The classification of APs is addressed in section four. Section 5 gives examples of the use of four different AP techniques and compares their results. The conclusions of the article are presented in section 6.

2. CONTINUOUS AUDITING

The concept of continuous auditing (CA) and the integration of AP tools into it are discussed in this section. There are several ideas of what CA systems are. Kogan et al. (1999) defined continuous auditing as a type of auditing that produces audit results simultaneously with, or a short period of time after, the occurrence of relevant events. Razaee, Elam, and Sharbatoghlie (2001) stress the systematic process of gathering electronic evidence under the paperless, real-time accounting system. One solution for this is that one part of the audit work focuses on monitoring transactions and comparing them to expected results on a continuous basis (Vasarhelyi, Kogan & Alles 2002). Conceptually, the continuous audit is an assurance service, where the time between the occurrence of events underlying a particular subject matter and the issuance of an auditor's opinion on the reliability of a client's representation of the subject matter is eliminated (Woodroof & Searcy 2001). The CICA/AICPA (1999) defines CA as "*a methodology that enables independent auditors to provide written assurance on a subject matter using a series of auditors' reports issued simultaneously with, or a short period of time after, the occurrence of events underlying the subject matter.*"

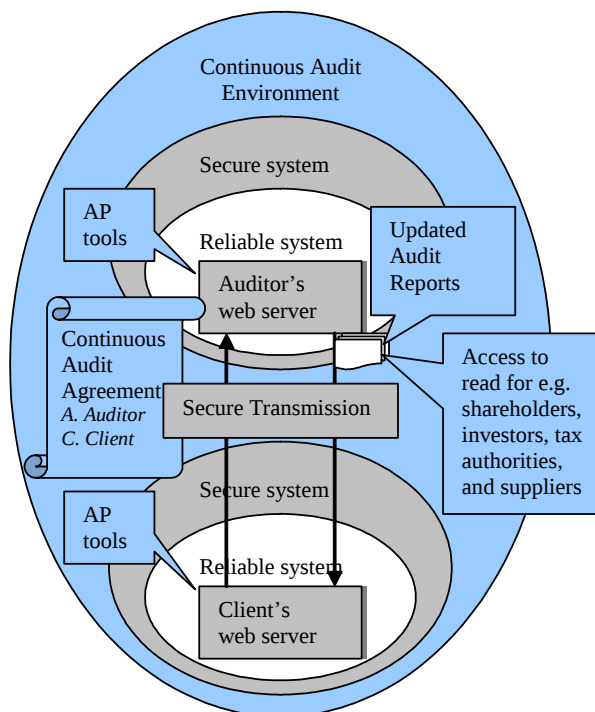


Figure 1 The framework of a continuous audit with AP (modified from Woodroof & Searcy 2001)

Woodroof and Searcy (2001) have introduced the framework for continuous auditing with interconnected web servers, continuous auditing environment with agreements, characteristics of a reliable and secure system, and evergreen reports. In Figure 1 we have embedded AP tools into this continuous auditing environment. In the Woodroof and Searcy (2001) framework, we like to emphasize the continuous audit agreement, i.e. the contract between the audit firm and the client. The third parties, such as shareholders, investors, tax authorities, and suppliers, could have access to read these updated audit reports. In the future this kind of continuous monitoring of the data transmission between the companies and authorities will be very significant as official authorities' reports move into the electronic form.

Woodroof and Searcy (2001) say that the continuous audit environment requires that the participating web servers are connected and given authority to communicate. The authority means that the client's web server allows the auditor controlled access to the client's database. The data flows through the client's system and is continuously monitored and analyzed using, for example, AP tools integrated in the system. AP tools could be placed either in the auditor's systems or in the client's system. Woodroof and Searcy (2001) stress that the automated processes within the continuous audit environment must be highly reliable. One way to approach the reliability is to look at the early SysTrustTM principles of *integrity*, *security*, *availability*, and *maintainability* (AICPA 2002b):

- Integrity means that the system is complete, accurate, timely, and authorized.
- Security means that the system is protected against unauthorized access.
- Availability means that the system is available for operation and use at the time of continuous audit agreement.
- Maintainability means that the system is updated when required and that the system's availability, security, and integrity are secured.

In the early days of computers, Kunkel (1974) argued that auditing by expectation on a continuous basis could substantially increase the efficiency and effectiveness of the audit function. Today, we have many different types of data management tools to create the expectations to be used in monitoring and controlling data. However, with small and medium-sized enterprises (SMEs) we do not have many applications or software to support the continuous auditing of data transmission. In many SMEs the "continuous" auditing is based on the traditional analytical review.

3. AUDIT PHASES WITH ANALYTICAL PROCEDURES

Several different terms are commonly used to describe the analytical procedures in auditing such as analytical auditing, analytical procedures, analytical review, analytical evidence, or analytical review procedures. In this article we have used the analytical procedures as an umbrella term for all the terms that produce analytical evidence for auditors. These procedures comprise the analysis of significant ratios and trends, including the investigation of fluctuations and relationships that are inconsistent with other relevant information or which deviate from expectations (IFAC 2003). AP may be performed:

- In the client acceptance/retention phase in order to settle the audit fee.
- In the planning phase to identify potential problem areas.
- In the testing phase to get evidence on account balances or transactions.
- In the overall review phase to gather evidence on the reliability of the financial statements with the auditor's knowledge of the business.

The audit process, also in the continuous audit environment, can be divided into three phases: *planning, testing, and overall review*. Figure 2 illustrates the audit phases with the AP.

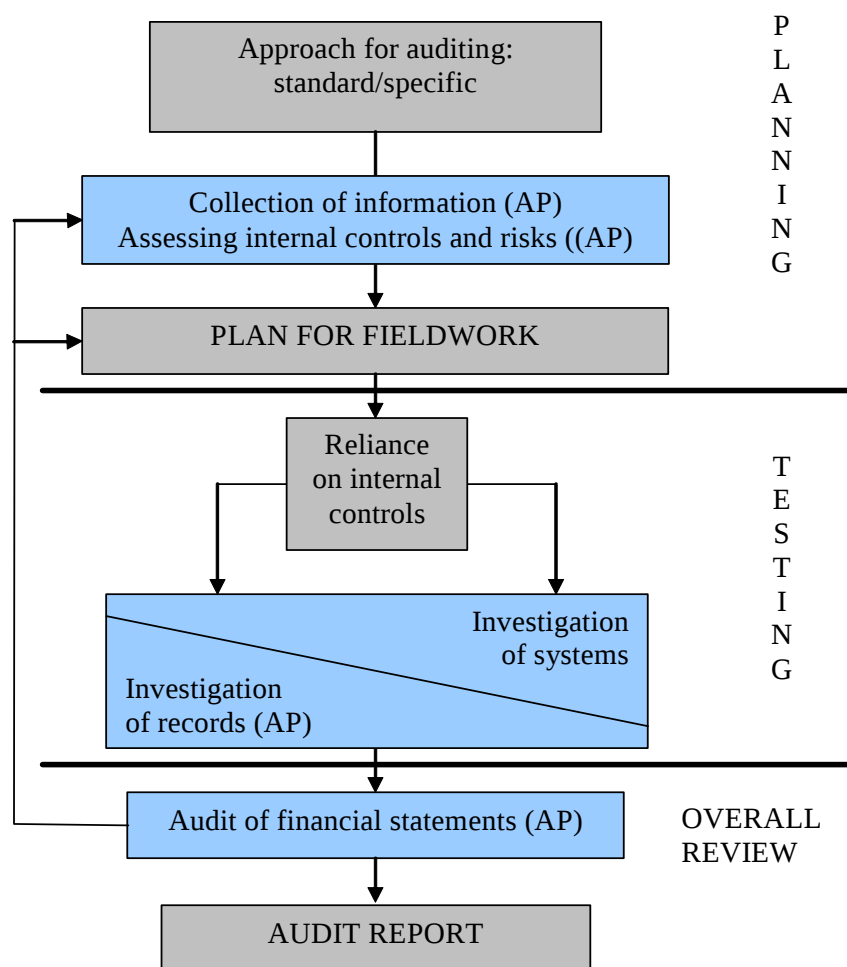


Figure 2 Audit phases with AP (modified from Riistama 2000)

An auditor might use different kinds of APs to become convinced of the reliability of the audit evidence. These analytical procedures (e.g. SAS 56, ISA 520) may include (Waddington, Moreland & Lillie 2001; Gauntt & Gletzen 1997; AICPA 2002a): comparison of current information with similar information for prior periods; comparison of current information prior periods; comparison of current information with budget or forecast or expectations of the auditor; study of relationships of financial information with the appropriate non-financial information; study of relationships among elements of information; comparison of information with similar information for other organizational units; comparison of information with similar information for the industry in which the organization operates. For example, in the municipal audit, budget-to-actual comparison of financial data is significant because municipal budgets have binding legal authorities (Johnson & Johnson 1995) In the audit of SMEs, the

comparison of current information with similar information for prior periods is very common.

Country-specific business and accounting cultures influence the way in which auditors use AR procedures in practice. For example, in the US the use of AR procedures in the planning and overall review phases of an audit is required under generally accepted auditing principles (GAAP). Furthermore, SAS 96 contains amendments adding specific documentation requirements to the SAS 56, which, at present, requires auditors to document the factors they considered in developing the expectation for a substantive analytical procedure (AICPA 2002a). Besides, auditors have to document the expectation if it is not evident from other documentation. According to SAS 96, the auditors should also document (a) the results of their comparison of that expectation with the recorded amounts or ratios they have developed from the recorded amounts, and (b) any additional auditing procedures they have performed in response to significant unexpected differences arising from the APs, as well as the results of such additional procedures.

In Finland the Finnish Institute of Authorized Public Accountants recommends the use of analytical procedures in the planning and overall review phases (KHT-yhdistys 2003). Principally, AR procedures could be performed at any phase of audit.

The research by Lin, Fraser, and Hatherly (2003) in Canada indicates that analytical procedures are extensively applied in practice, particularly by larger audit firms, and that their use dominates the overall review phase of audit regardless of the firm size. These results are comparable with earlier research conducted in the US (Ameen & Strawser 1994; Fraser, Hatherly & Lin 1997). One explanation for the greater use of analytical procedures by larger audit firms is the client size. Larger clients are more likely to have internal control systems that facilitate the reliance of accounting data and produce documents and data for AP purposes.

Table 1 shows examples of the purposes of analytical procedures for each of the three audit phases. The X in the boxes in the matrix indicates that a certain purpose is applicable to that phase. The purposes vary in different phases of the audit.

Table 1	Timing and purposes of analytical procedures		
	Planning	Testing	Overall Review
Indicating material error	X	X	X
Assessing going concern	X		X
Indicating management fraud	X	X	X
Reducing detailed test	X	X	
Assessing internal control risk	X		
Forecasting audit fee	X		X

4. THE CLASSIFICATION OF ANALYTICAL PROCEDURES

Various techniques or methods may be used in performing the analytical procedures. These techniques range from simple comparison to complex analyses (e.g. Leitch & Chen 2003; Blocher, Krull, Tashman & Yates 2002; Fleming 2004). For example, in this article we use four different types of AP technique for estimating account values in order to direct auditors' attention.

Auditing researchers have classified analytical procedures slightly differently. Blocher and Patterson (1996) have identified three types of AR techniques: *trend analysis*, *ratio analysis* and *model-based*. Fraser et al. (1997) have provided a slightly broader classification perspective for AR techniques: non-quantitative (NQT) or *judgmental*, such as scanning; simple quantitative (SQT), such as trend, ratio and reasonableness tests; and advanced quantitative (AQT), such as regression analysis and artificial neural networks (ANNs) (Koskivaara 2004).

These techniques differ significantly in their ability to identify a potential misstatement. Judgmental techniques include the auditor's subjective evaluations based on client knowledge and past experience. In the literature the judgmental-based procedures are often studied under the behavioural aspects, see e.g. O'Donnell (2002). Trend analysis assesses whether there is a functional relationship between the variables over time.

Ratio analysis incorporates the relationships between two or more variables. For example, turnover ratios are useful because there is typically a stable relationship between sales and other financial statement accounts, such as receivables and inventory. Ratios are easy to compute, and therefore they are tempting, but their interpretation is problematic, especially when two or more ratios provide conflicting signals. Indeed, ratio analysis is often criticized on the grounds of subjectivity, i.e. the auditor must pick and choose ratios in order to assess the overall performance of a client.

In a reasonableness test the expected value is determined with the data partly or wholly independent of the accounting information system, and for that reason, evidence obtained through such a test may be more reliable than evidence gathered using only an accounting information system. For example, the reasonableness of the total annual revenue of a freight company may be estimated by calculating the total tons carried during the year and the average freight rate per ton.

Regression analysis models the relationships between the variables and the predictors. In the regression analysis model the auditor may predict financial and operating data with the help of economic and environmental data. ANNs learn from examples and then generalize the learning with new observations. Compared with regression analysis, we do not need an *a priori* model because ANNs are data-driven models, which are capable of identifying and simulating non-linear relationships in the data with no *a priori* assumptions about the distribution properties of the data. This means that ANNs are assumption-free approaches for approximating functions from sample data.

Kinney and Felix (1980) present a summary table of the characteristics of AP techniques. In Table 2 we have kept the classification scheme but renamed the techniques according to Fraser et al. (1997). Auditors have to be aware of the

characteristics of AP techniques in order to interpret the evidence they provide for use in the audit process. However, when using SQTs or AQTs auditors should consider the possible effects of any uncorrected accounting errors in earlier data. Indeed, the range of deviations from what might be reasonable will still largely remain a subjective assessment. Ultimately, the auditor's choice of procedures, techniques and level of application is a matter of professional judgement (IFAC 2003).

Table 2 Characteristics of AP techniques

AP technique	Information used	Predictions determined	Reliability of predictions determined
NQT	Any available information	Subjectively	Subjectively
SQT	Earlier audited values	Objectively	Objectively
AQT	Earlier audited values and quantifiable environmental information	Objectively	Objectively

Researchers have also stated that analytical procedures are tools management could use as part of its responsibilities for controlling (Lee & Colbert 1997; Colbert 1994). A management accountant could effectively utilize the same benefits of analytical procedures that auditors do. Accountants could apply the analytical procedures to various accounts to search for trends and relationships that do not appear reasonable. If analytical procedures are applied before the account values are integrated into the financial statements or prior to auditors' investigations, possible faults can be corrected in advance.

5. CASE RESULTS OF DIFFERENT AP TECHNIQUES

In this section we use four different AR procedures, i.e. the methodology of the research, to produce monthly sales expectations. Two of these procedures belong to the SQT category, namely the mean of three previous years' value and the previous year's value, and two of the AR procedures belong to the AQT category, namely regression analysis and ANN. These categories and their limitations are explained in the previous section. All expectation values are produced with the spreadsheet application with neural networks component, i.e. NeuralystTM.

Table 3 presents the data used in this study. The first three years are used for building or training the model. The fourth year is used for evaluating the models, i.e. comparing the four different expectation values to the actual values. The data is based on an earlier study conducted by Wallin (1998).

Wallin (1998) found that the sales could be predicted with the formula: $\text{Sales} = -198.264 + 0.733 \cdot \text{Volume} \cdot \text{Index} + 2.128 \cdot \text{Index}$. The regression values in Table 4 are calculated with the help of this formula. The ANN values in Table 4 are received from the supervised learning method. In the ANN model, volume index, volume*index and month indicator have been inputs and sales has been output. The ANN model has one hidden layer and learning rate 0.2 and momentum 0.3 to optimize the learning process. Furthermore, the adaptive learning rate is active, which speeds up the learning process when the ANN is far away from the correct solution and slows it down when the ANN gets closer. Likewise, the mean sales of the three previous years and the previous year's value for the sales are in Table 4. The best results were achieved with the ANN and regression methods. The mean and the previous year's value were clearly worse in this sample.

Figure 4 shows the actual values in currency differences achieved with the ANN and regression methods (i.e. the actual value is on the zero line). Figure 5 shows the same differences in percentages. On average, the ANN method differs from the actual by 4% and the regression differs from the actual by 4.5%. The range is the same for both models, i.e. [-10.9], although the ANN was a little better than the regression model. From the methodological point of view, it was good that the expectation sales values were always on the same side of the actual value.

From the auditing point of the view, the most attention grabbing are the biggest differences between the expectation and actual values (see Figure 4). Therefore, in this particular case the most interesting items are the sales of April and October, which are clearly below the expectations received with the prediction models. Indeed, both methods indicate similar alarms. In July, August and November respectively the actual sales are higher than the predicted. Furthermore, the auditor might take a closer look at those values that differ by more than +/-5 % from the expectations (i.e. ask the client for an explanation), especially if two or more analytical procedure techniques give the same results. In this case this means the sales of April, July and November (see Figure 5).

Table 3 Training and testing data for building the models

	Month	Volume	Price index	Vol.*P.index	Sales
Train	1	388	100	388	312
Train	2	392	100	392	320
Train	3	422	100	422	320
Train	4	494	100	494	363
Train	5	721	100	721	512
Train	6	470	100	470	334
Train	7	567	100	567	390
Train	8	263	100	263	185
Train	9	683	100	683	528
Train	10	483	100	483	395
Train	11	499	100	499	380
Train	12	496	100	496	375
Train	1	739	100	739	568
Train	2	604	100	604	448
Train	3	787	100	787	613
Train	4	644	100	644	452
Train	5	734	100	734	540
Train	6	653	100	653	531
Train	7	815	100	815	621
Train	8	467	100	467	363
Train	9	698	100	698	515
Train	10	825	100	825	605
Train	11	717	100	717	646
Train	12	805	100	805	629
Train	1	581	100	581	414
Train	2	614	100	614	528
Train	3	1152	116	1336.32	1010
Train	4	733	116	850.28	699
Train	5	916	116	1062.56	831
Train	6	673	118	794.14	638
Train	7	707	122	862.54	675
Train	8	750	122	915	710

Train	9	692	122	844.24	711
Train	10	742	122	905.24	723
Train	11	679	122	828.38	660
Train	12	626	122	763.72	633
Test	1	799	122	974.78	820
Test	2	593	122	723.46	591
Test	3	596	122	727.12	601
Test	4	387	122	472.14	371
Test	5	642	126	808.92	688
Test	6	519	126	653.94	551
Test	7	704	126	887.04	793
Test	8	492	126	619.92	513
Test	9	528	126	665.28	587
Test	10	361	126	454.86	387
Test	11	501	126	631.26	579
Test	12	424	126	534.24	486

Table 4 Comparison of sales per different methods

Month	Actual	ANN	Regression	Mean	Previous
1	820	809	776	431	414
2	591	600	592	432	528
3	601	599	594	648	1010
4	371	407	407	505	699
5	688	666	663	628	831
6	551	548	549	501	638
7	793	718	720	562	675
8	513	527	524	419	710
9	587	561	558	585	711
10	387	420	403	574	723
11	579	545	533	562	660
12	486	483	461	546	633

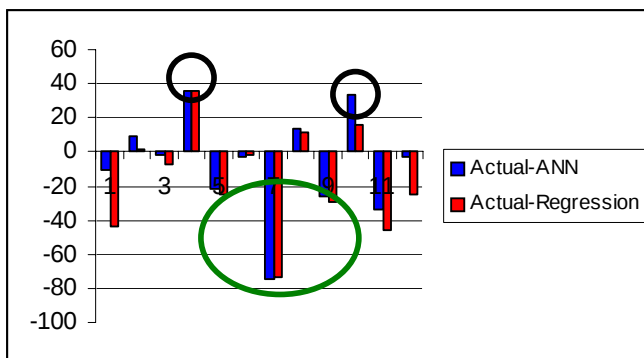


Figure 4 ANN and regression differences in currency

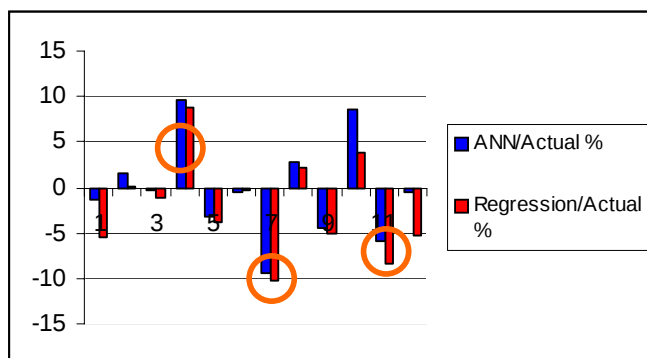


Figure 5 Percentage differences of the ANN and regression methods

6. CONCLUSION

This article started by presenting the continuous auditing environment embedded with the analytical procedures. The timing and purposes of analytical procedures were presented, and different characteristics of the analytical procedures were discussed. Then four different AP techniques were used to form expectations for the monthly sales values. The ANN and regression methods turn out to be equally good. These kinds of methods could be embedded into the continuous audit environment, especially when most data transmission between companies and their stakeholders is moved into the electronic form. In this study we used aggregated monthly data. However, in many branches it might be too general in order to alarm auditors or authorities early enough when we really move into real e-Society.

Therefore, there is a huge demand to develop transaction-based continuous auditing tools. The development is very important when standards like XBRL become a general means of communication between companies and their stakeholders and authorities (Alles, Kogan, Vasarhelyi & Warren Jr 2006; Boovee, Kogan, Nelson, Strivastava & Vasarhelyi 2005). Indeed, the use of innovations only provides opportunities to improve audit effectiveness if the training, software, and information security issues are at the appropriate level. For example, auditors will need training in using data-mining tools and evaluating results. The CA environment requires auditors who have information system skills and a thorough understanding of statistical techniques. Strong security controls surrounding the transmission of data to the auditor and the auditor's database are essential for continuous auditing.

REFERENCES

- AICPA (2002a) American Institute of Certified Public Accountants Audit and Attest Standards, Statements on Auditing Standards (SAS) No. 96, Audit Documentation. <<http://www.aicpa.org/members/div/auditstd/riasai/sas96.htm>>, retrieved 13.1.2006.
- AICPA (2002b) American Institute of Certified Public Accountants, Inc. and Canadian Institute of Chartered Accountants (CICA) SysTrustTM Principles and Criteria. <<http://www.aicpa.org/assurance/systrust/princip.htm>>, retrieved 23.1.2004.
- Alles, Michael - Kogan, Alexander - Vasarhelyi, Miklos - Warren Jr, J Donald (2006) Guarding the auditing guards. *Strategic Finance* Vol. 87, No: 8, 30–35.
- Ameen, Elsie C. - Strawser, Jerry R (1994) Investigating the Use of Analytical Procedures: An Update and Extension. *Auditing: A Journal of Practice & Theory* Vol. 13, No: 2, 69–76.
- Blocher, Edward - Krull, Jr., George W. - Tashman, Leonard J. - Yates, Stephen V. N: (2002) Updating Analytical Procedures. *The CPA Journal* Vol. No: November, 36–41.
- Blocher, Edward - Patterson, George F. Jr. (1996) The Use of Analytical Procedures: The Importance of Expectation and Precision. *Journal of Accountancy* Vol. No: February, 53.
- Boovee, Matthew - Kogan, Alexander - Nelson, Key - Strivastava, Rajendra P - Vasarhelyi, Miklos A (2005) Financial Reporting and Audit Agent with Net Knowledge (FRAANK) and eXtensible Business Reporting Languages (XBRL). *Journal of Information Systems* Vol. 19, No: 1, 19–41.
- CICA/AIPCA (1999) Continuous auditing - Executive Summary. <<http://www.cica.ca/9/8/9/index1.shtml>>, retrieved 15.11.2006.
- Colbert, Janet L. (1994) Analytical Procedures for Management Accountants and Auditors. *Managerial Auditing Journal* Vol. 9, No: 5, 3–7.
- Fleming, John M (2004) Analytical Procedures are a Helpful Tool. *Pennsylvania CPA Journal* Vol. 74, No: 4, 3–4.
- Fraser, Ian A. M. - Hatherly, David J. - Lin, Kenny Z. (1997) An Empirical Investigation of the Use of Analytical Review by External Auditors. *The British Accounting Review* Vol. 29, No: 1, 35–47.
- Gauntt, James E. Jr. - Gletzen, G. William (1997) Analytical Auditing Procedures. *Internal Auditor* Vol. 54, No: 1, 56–60.
- Groomer, S. Michael - Murthy, Uday S. (1989) Continuous auditing of database applications: an embedded audit module approach. *Journal of Information Systems* Vol. 3, No: 1 (Spring), 53–69.
- IFAC (2003) International Auditing and Assurance Standards Board: International Standard of Auditing 500 Audit Evidence. <<http://www.ifac.org/Members/DownLoads/AuditRisk-ISA500.pdf>>, retrieved 28.1.2004.
- Johnson, Eric N. - Johnson, Laurence E. (1995) Differences in municipal vs. commercial audit planning analytical procedures. *The CPA Journal* Vol. 65, No: 12,

50–51.

KHT-yhdistys (2003) *Tilintarkastusalan suosituksset 2003*. KHT-yhdistys: Helsinki.

Kinney, William R. Jr. - Felix, William L. Jr. (1980) Analytical review procedures. *Journal of Accountancy* Vol. 150, No: 4, 98–102.

Kogan, Alexander - Sudit, Ephraim F. - Vasarhelyi, Miklos A. (1999) Continuous online auditing: a program of research. *Journal of Information Systems* Vol. 13, No: 2, 87–103.

Koskivaara, Eija (2004) Artificial neural networks in analytical review procedures. *Managerial Auditing Journal* Vol. 19, No: 2, 191–223.

Kunkel, J. Gregory (1974) Continuous auditing by exception. *Management Accounting* Vol. 56, No: 1, 45–48.

Lee, Minwoo - Colbert, Janet L. (1997) Analytical procedures: management tools for monitoring controls. *Management Decision* Vol. 35, No: 5, 392–397.

Leitch, Robert A. - Chen, Yining (2003) The Effectiveness of Expectations Models in Recognizing Error Patterns and Generating and Eliminating Hypotheses While Conducting Analytical Procedures. *Auditing: A Journal of Practice & Theory* Vol. 22, No: 2, 147–170.

Lin, Kenny Z. - Fraser, Ian A. M. - Hatherly, David J. (2003) Auditor analytical review judgment: a performance evaluation. *The British Accounting Review* Vol. 35, No: 1, 19–34.

O'Donnell, Ed (2002) Evidence of an Association between Error-Specific Experience and Auditing Performance during Analytical Procedures. *Behavioral Research in Accounting* Vol. 14, No: 179–195.

Razaee, Zabihollah - Elam, Rick - Sharbatoghlie, Ahmad (2001) Continuous auditing: the audit of the future. *Managerial Auditing Journal* Vol. 16, No: 3, 150–158.

Riistama, Veijo (2000) *Tilintarkastus*. WS Bookwell, Porvoo.

Waddington, Barbara A. - Moreland, Keith A. - Lillie, Thomas (2001) The effectiveness of analytical procedures in detecting existing misstatements improves with knowledge of the business. *The CPA Journal* Vol. No: May, 50–51.

Wallin, Jan (1998) Analytisk gransking med hjälp av Exel och regressionanalysis. *Tilintarkastus - Revision* Vol. No: 1, 37–40.

Vasarhelyi, Miklos A. - Halper, Fern B. (1991) The continuous audit of online systems. *Auditing: A Journal of Practice & Theory* Vol. 10, No: 1, 110–125.

Vasarhelyi, Miklos A. - Kogan, Alexander - Alles, Michael (2002) Would continuous audit have prevented the Enron mess? *The CPA Journal* Vol. 72, No: 7, 80.

Woodroof, Jon - Searcy, DeWayne (2001) Continuous audit: model development and implementation within a debt covenant compliance domain. *International Journal of Accounting Information Systems* Vol. 2, No: 3, 169–191.