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Contents

Preface

This book presents the results of Polish-Ukrainian scientific cooperation. It contains the papers prepared for the 10th international conference "Quantitative Methods in Accounting and Finance". Accounting and finance face nowadays many challenges. They require both an international and local approach, they need to be considered from the theoretical and practical point of view, and they also encourage general and specific analysis.

Support from quantitative methods is needed in order to discover, implement and verify new finance and accounting trends, methods and instruments. The research papers which are part of this book present different aspects of accounting and finance combined with a quantitative, in particular Econometric, approach.

Some of the papers focus on methodology of measurement, estimation and forecasting of financial phenomena, especially those related to investment processes. Others address specific problems of accounting such as accounting solutions for different branches, legal issues of accounting, responsibility and reporting. An alternative approach was also undertaken and the roles of a narrative and culture in accounting were presented.

The variety of papers selected for this issue ensures the complexity of the book. It provides theoretical as well as empirical material which can be used in further research and in business practice, particularly in accounting and finance. We hope that the content of the book provides a starting point for scientific discussion and practical changes.

Marta Nowak

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Quantitative Methods in Accounting and Finance

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EVALUATING THE USEFULNESS OF QUANTITATIVE METHODS AS ANALYTICAL AUDITING PROCEDURES

OCENA UŻYTECZNOŚCI METOD ILOŚCIOWYCH JAKO AUDYTOWYCH PROCEDUR ANALITYCZNYCH

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Summary: The paper presents the comparative study of several quantitative methods from the point of view of their usefulness as analytical procedures. In particular the article deals with analytical procedure expectation models which can be used as reference in analytical review. As professional auditing standards and academic research suggest, these methods may be used both in internal and external auditing. In the paper there were subjective evaluation, rule of thumb and various simple and advanced quantitative methods depicted, such as time trend analysis, ratio analysis, vector autoregression, regression analysis and data envelopment analysis. Moreover there were described advantages and limitations of each method showing its potential usefulness and conditions of work. Some results of different empirical research and analysis are widely quoted in the article.

Keywords: quantitative methods, analytical review procedures, auditing.

Streszczenie: W artykule przedstawiono analizę porównawczą kilku metod ilościowych z punktu widzenia ich przydatności jako procedur analitycznych. W szczególności artykuł dotyczy modeli stosowanych do formułowania oczekiwań audytora, służących za punkt odniesienia podczas wykonywania procedur analitycznych. Jak wskazują standardy zawodowe audytu i wyniki badań naukowych, metody te mogą mieć zastosowanie zarówno w audycie wewnętrznym, jak i w rewizji finansowej. W artykule przybliżono metody bazujące na subiektywnej ocenie, praktycznych zasadach, a także różne proste i zaawansowane metody ilościowe, takie jak analiza trendów czasowych, analiza wskaźnikowa, model wektorowej autoregresji, analiza regresji oraz metoda *Data Envelopment Analysis*. Ponadto omówiono zalety i ograniczenia poszczególnych metod, wykazujące ich potencjalną użyteczność, a także zasady stosowania. W tekście zacytowano również wyniki niektórych badań i analiz.

Słowa kluczowe: metody ilościowe, procedury analityczne, audyt.

1. Introduction

Analytical auditing procedures, also called analytical procedures, are the study and comparison of the relationship of information, both financial and nonfinancial.

Analytical procedures are expected to identify differences that are not expected and the absence of differences when they are expected. Once alerted, the auditor must investigate why the situation has occurred. These could be the result of errors, irregularities, illegal acts, unusual events or transactions, method of accounting.

Analytical procedures offer an efficient and very effective tool for evaluating information gathered in an audit. The key concepts in using analytical procedures are: (a) identifying the relationships between various pieces of data and (b) identifying expected results. The relationship concept addresses itself in understanding how aspects of the organization work together [Sawyer, Dittenhofer, Scheiner 2005]. For example, if a production plan calls for a constant level of output of the same products from one year to the next and no material changes in production methods occur, the relationship of personnel and raw material to output should remain reasonably constant.

One of the most basic ideas in analytical procedures is reasonableness. It implies sensible and rational explanations of change or constancy. Things do not change unless there is some cause.

Analytical auditing procedures may involve rations, percentages, monetary amounts, quantities, or other means of comparison of one factor to another. The comparison does not have to employ the same unit of measure. A comparison of units of output to cost of materials from one period to another may use mixed units of measurement in a consistent fashion to identify changes.

Analytical auditing procedures can be classified into the three groups [Tabor, Willis 1985]:

- Non-quantitative procedures – consist of a variety of methods which involve the application of accounting and business knowledge to judge the completeness, validity, and accuracy of an account balance or relationship. Examples include subjective evaluation of external information such as external data bases or economic indices, or reviewing internal information such as personnel files, minutes of important meetings, correspondence files, production records, etc.
- Simple quantitative procedures – consist of a variety of simplified quantitative procedures used to highlight or identify relationships, reasonableness, etc., of account balances. Examples include ratio analysis, judgmental time-trend analysis, and variance analysis.
- Advanced quantitative procedures – consist of a variety of techniques using economic or statistical models to relate an account balance to environmental variables that theoretically cause the account balance to vary. The most notable example in this category is regression analysis and data envelopment analysis.

The purpose of this paper is to evaluate the usefulness of the above mentioned procedures in the analytical auditing process.

2. Subjective evaluation

The first analytical review method, which has a non-quantitative nature, is simply a subjective evaluation by the experienced auditor. By using insight and professional judgment and by drawing on his/her knowledge of the client's specific environmental data, the auditor can determine a reasonable range of values for the audited balance. Since all the auditor's knowledge of the client can be incorporated in his/her judgment, the auditor may be very comfortable with the assessed range for the audited values. The auditor may consider data that is external to the company, such as local bank deposits, gross national product measures and employment rates, and internal data, such as production records and related account balances, budgeted amounts (reflecting management expectations) and knowledge of past audits that may indicate which balances are most likely to contain errors and the likely need for adjustment of certain accounts [Kinney, Murray, Felix 1980].

The primary advantage of the subjective method is its apparent ability to use any data available. The auditor's subjective approach can in effect, be "multivariate" in nature. Using this method, specific events such as especially adverse weather conditions or construction problems, can be considered conveniently.

The major limitation of this method is its subjective nature and therefore the difficulty of objectively recreating the same results by others. Different experts may see the same conditions as yielding far different reasonable values and therefore make different subjective assessments of the reliability of the results of the analytical review.

3. Rule of thumb

A second approach might be called the rule-of-thumb method. This method uses relatively simple quantitative relationships by comparing the previous year's audited values with the current audit year's recorded amounts. Rather than make a prediction about an audited value, the auditor merely decides to investigate (or not investigate), depending on whether the difference between years exceeds some preset critical value. An example is the ‘'investigation rule" that recommends investigation if the current book balance (or ratio) differs from the last year's audited amount by more than 15 percent. Perhaps the simplest rule of thumb is to predict an audit adjustment for the current year if an adjustment was made last year [Kinney, Murray, Felix 1980].

Kinney, W.R., Jr. [1979], reports on an empirical study suggesting that such methods may be fairly effective. For a sample of 44 small manufacturing firms, the author found that rules of thumb signal a potential audit adjustment in about five of the six accounts for which a material audit adjustment was eventually made.

Although simple rules of thumb may not will be as effective as other methods which use more information and computation, their use may surely be economically beneficial as a first attempt because they seem to be fairly reliable and very inexpensive to apply.

4. Time trend models

Time trend analysis is a specialized form of analytical auditing procedure used primarily to analyze the changes in account balances, other financial information, or operational information over time. It is the most commonly used quantitative technique and has an application in both substantive and compliance testing. It is often used to identify performance indicators (profitability factors), highlight significant changes, and assess how past performance had led to the present position [Sawyer, Dittenhofer, Scheiner 2005].

Time trend models use very little information and can be applied on a totally objective basis, although the final results should be tempered by a judgmental evaluation of other influences on the balance. Time trend methods involve extrapolating past observations of trends into the present audit period. The information required is simply the past audited values of the account in question. Parts of past audited values (such as monthly balances or segment balances) are not ordinarily audited, and uncorrected accounting errors (for example, monthly cutoff errors) may influence the auditor's assessments for the current year. When using time trend analysis the auditor should consider the possible effects of any uncorrected accounting errors in past data [Kinney, Murray, Felix 1980].

As an example of the use of such methods, the auditor could plot a company's past total cost on the vertical axis and the time period on the horizontal axis of graph paper. The past trend in total cost might then be projected into the current period by a visual projection of an average or trend line into the current period. Alternatively, the auditor might follow a numerical approach by the high-low method, or least-squares method [Drury 2012].

The advantage of using these methods is that the projection of the past trend into the current period can be rather objective and verifiable. However, these methods also have some limitations. There is considerable subjectivity in their application in audit practice because the range of deviations from the trend that might reasonably be expected must still be largely a subjective assessment. The regression method on time trend data will usually yield deviation ranges that are far too wide for meaningful audit reliance. The mere passage of time does not explain much of the differences in accounting numbers over time. Even advanced statistical time trend methods cannot predict accounting series with great precision [Kinney 1978].

4.1. Ratio analysis

Ratio analysis is a discrete subset of trend analysis that is used primarily to compare relationships among financial statement accounts at a point in time. Ratio analysis can be used for examining both income statement accounts and balance sheet accounts. It is most effective, however, in evaluating the variations in the income statement accounts, because of the greater cause-effect relationships [Sawyer, Dittenhofer, Scheiner 2005].

There are two most often used methods of ratio analysis: common-size statement and financial ratios. The first approach is often classified as "vertical analysis". It converts each account balance to a percent of another relevant aggregate balance. The common example is relating all income statement accounts as a percent of sales.

The second approach expresses the relationship between account balances to reflect useful measures of position or change. An example would be the inventory turnover, which can be calculated as average inventory divided by costs of goods sold. These ratios are generally classified as activity, liquidity, leverage, or profitability ratios.

Ratio analysis have traditionally been performed to highlight the red flags by comparing the relative performance of a client as compared to the auditor's expectations based on the industry and/or the client's own previous years' performance [Arens, Elder, Beasley 2003, p. 340].

The main problem with the traditional ratio analysis is the use of subjective weights that are often unstated, and auditors' choices of specific ratios to compare and assess the overall health of a client [Feroz, Kim, Raab 2005].

4.2. Vector autoregression

Vector autoregression (VAR) has been developed in the late 1980s and has been applied extensively in forecasting macroeconomic and microeconomic variables. VAR was first proposed by Sims (1980), as a modeling approach to bypass the many problems associated with the more traditional simultaneous-equation structural econometric models. VARs are dynamic models of a group of time series. All equations in the system have identical constant terms and lagged values of the dependent (endogenous) variables. These equations form a vector of as many autoregressions as the number of endogenous variables included in the system. In effect, these models contain only endogenous variables.

VARs have some practical advantages over regression models [Dzeng 1994]. First, VARs treat all variables as endogenous, avoiding the need to obey specific theoretical, causal relationships, which usually restrict regression-type models. This feature is especially important in analytical procedure applications, since the professional auditing literature does not include any formal theories to guide auditors in selecting different variables to be included in analytical procedure expectation models. However, this does not mean that auditors can blindly include any explanatory variables. Relevance to the audit account is still a primary consideration when selecting variables for the model.

Second, VARs do not need the kind of strict statistical assumptions regressions rely on. This factor reduces significantly the model-building effort required of the auditor. Rather than go through many diagnostic tests, as required of most well-specified regressions, an auditor using VARs can follow normal case modeling procedures and derive forecasts in minutes.

Another VAR's advantage is that when forming expectations beyond the model estimation period, VARs do not need known future values of the exogenous variables

to derive predicted values for the endogenous variables as regressions do, because all variables included are endogenous.

VAR does have two disadvantages, however, particularly from a practical point of view. For one thing, VAR's coefficients are not as meaningful and readily interpretable as regression models' coefficients due to its multi-equation, multi-feedback nature. Since all variables in a VAR appear in all equations, the complicated dynamic interactions among the variables are captured by the entire system, not by a single equation, thus making it difficult for a non-statistician auditor to understand and interpret.

Another weakness of VAR is that, in its general form, VAR requires long time-series, since each equation usually contains several variables and several lags for each, which can easily add up to 20 or 30 terms. This overparameterization problem may cause large out-of-sample forecast errors. Fortunately, Litterman [1986a; 1986b] has developed a Bayesian approach which significantly alleviates the degrees of freedom problem.

5. Regression analysis

Regression analysis is used to examine relationships among two or more variables. It measures the extent that a change in one of the quantities is accompanied by a charge in another or others. It can be used to relate the account balance to environmental variables that theoretically cause the account balance to vary. Simple regression analysis uses only two variables. For example, the increases in company costs tend to be accompanied by increases in its activity. One of the variables is called the independent variable. In the example of the company, the volume of activity levels or cost driver for the period is the independent variable. The other variable is called the dependent variable. It is associates with the independent variable – the total cost for the period tends to depend on the activity level.

This relationships can be plotted on a graph called a scatter graph. The items plotted disclose the trend or historical information. The independent variable is normally plotted on the horizontal axis while the dependent variable is plotted on the vertical axis. For example, the line fitted to the scattered dots represents the relationships between the total cost for the period (the dependent, or Y variable) and an activity level (the independent, or X variable). Merely looking at the points on a scatter graph is not the most accurate way of defining the relationship between two variables. Looking does not reveal which is the best fit for the line or the curve threading its way through the scattered points.

A more accurate method is to show the relationship between the two variables by the "least squares method." This method is a mathematical tool used to study the relationship between variables. If that relationship is truly linear – or close to linear – the result of using least squares is a better prediction. In the formula for determining the best fit, the dependent variable – the one we want to predict – is designated as

the Y variable (the total cost, for example). The independent variable is designated the X variable (volume of activity levels). The least squares method is based on the idea that the value that best fits a given set of quantities in one that minimize the sum of the squared differences between itself and these quantities. For example, according to the least squares principle, the arithmetic mean of a set of repeated experimental measurements subject to random error is the value that best represents the set. Computer programs are available easily performing regression analysis.

When only two variables are involved in the analysis, the technique is known as simple regression analysis. Where two or more independent variables are involved, the technique is called multiple regression analysis. For example, cost of goods sold may be related to the number of units sold for the period, a price index based on prices paid for a product's major materials components and wage rates. By measuring past costs of goods sold, units sold, price indexes and wage rates and by determining the usual relationship between the variables, the auditor can extend the relationship into the audit period. This is quite different from a simple time trend extrapolation because it allows the objective consideration of current audit year values in the quantity, price and wage factors.

Projections are not necessarily 100 percent accurate. The projections will lie within some range of reliability. The corresponding question is: how closely are the variables related? This relationship can be quantified with a number called the correlation coefficient r. The number r ranges from +1.00 (perfect positive) through 0.00 (perfect random correlation) to –1.00 (perfect negative correlation).

A regression analysis can be employed to predict the expected. It is being used increasingly in business to disclose trends and identify aberrations. Internal auditors can use it to help managers make predictions or to test management's predictions. Some uses of regression analysis are to analyze supply and demand, predict consumer receivables, forecast burden rates, analyze markets, study price behavior, and study advance reservations and predict account balances.

Auditors can use regression analysis in their audit or investigative work. They can tell where the trends may be leading and whether those trends point to aberrant conditions. They may also point to a dependent variable that is not being achieved. Thus, indicators so plotted might point to matters that ordinary operating reports do not identify, or the trends may point to potential danger spots [Sawyer, Dittenhofer, Scheiner 2005].

Regression models are more objective in their use and have the potential for more reliance than simple quantitative procedures. Knechel study [1988] provided evidence that regression based analytical review increased audit effectiveness relative to an audit strategy that did not use analytical review. Moreover, regression models proved to be very efficient in detecting potentially material misstatements. However the auditors participating in Tabor and Willis [1985] study indicated that they used advanced quantitative procedures, like regression analysis, only in the detailed substantive area. The methods were not used in the audit planning nor final review area.

The explanatory power of regression-based structural models in auditing can be quite high. Correlations of .90 or above are relatively common. This implies that about 81 percent of the variation in an account balance can often be explained by environmental information. Simulated account balances and environmental data with correlations around .90 have frequently been shown to allow a substantial reduction in planned substantive tests of details. Since regression analysis allows the objective calculation of both predictions and ranges of reasonable values, the method has the advantage of an objective, verifiable measure of the reliability of the analytical review results [Kinney, Murray, Felix 1980].

A regression analysis has some limitations. It does not answer "why?" It does not prove cause and effect. The statistical determination of relationship does not explain the reason – it merely establishes a fact. So, as in everything else, when the auditors obtain the facts they must then apply judgment [Sawyer, Dittenhofer, Scheiner 2005].

In any mathematical technique, the procedure cannot be carried out mechanically, the assumptions must be valid and the results must make sense. For example, it may be very misleading to use a cost function to estimate the total costs for ranges of activities outside the range of observations that were used to establish the cost function. This is because a cost function is normally only valid within the range of the actual observations that were used to established the equation. Outside this range of observations there may exist a curvilinear relationship between costs and activity.

Moreover the method may involve considerable costs in developing accurate data for use in the regression model and ordinarily requires the use of a computer program to make calculations. However, the inexpensive availability of time-shared computer programs has greatly reduced the latter problem [Kinney, Murray, Felix 1980]. Moreover, regression analysis require from auditors gaining an extensive knowledge of mathematical or statistical techniques [Daroca, Holder 1985].

6. Data Envelopment Analysis

Data envelopment analysis (DEA) is a linear programming methodology to measure the efficiency of multiple decision-making units when the production process presents a structure of multiple inputs and outputs. DEA has been used for both production and cost data. Utilizing the selected variables such as unit cost and output, DEA software searches for the points with the lowest unit cost for any given output, connecting those points to form the efficiency frontier. Any company not on the frontier is considered inefficient. A numerical coefficient is given to each firm, defining its relative efficiency. Different variables that could be used to establish the efficiency frontier are: number of employees, service quality, environmental safety, and fuel consumption. An early survey of studies of electricity distribution companies identified more than thirty DEA analyses – indicating the widespread application of this technique to that network industry [Jamasb, Pollitt 2001].

The main advantage to this method is its ability to accommodate a multiplicity of inputs and outputs. It is also useful because it takes into consideration returns to scale in calculating efficiency, allowing for the concept of increasing or decreasing efficiency based on size and output levels. A drawback of this technique is that model specification and inclusion/exclusion of variables can affect the results [Berg 2010].

DEA may be a useful analytical procedure for auditors, especially in the planning stage of the audit, to determine the extent of audit and to assess the preliminary risk level of the client. Feroz, Kim, Raab [2005], argue that DEA can also be used in the overall review stage to detect any anomalies and to assess the reasonableness of financial statements. DEA-based analytical procedures can provide consistent and reliable red flags and benchmarks for auditors to compare a client to other firms in the same industry. Feroz, Kim, Raab [2005], provide an illustrative use of DEA as an analytical procedure for auditing a client in the oil and gas industry. The authors also provide validation for DEA as an analytical procedure.

7. Conclusions

Even though research shows that sophisticated quantitative methods provide more accurate expectations than simple quantitative methods, they also require relatively large amounts of historical data, a stable trend, familiarity with modelling and possibly data entry. Does the potential benefits justify the added cost? Future researchers may wish to investigate this issue.

We still need to know more about the reliability of such procedures in practice. It seems likely that some types of methods will prove reliable and efficient under some conditions and other methods will be preferred in other circumstances. Experimentation and the sharing of experiences in using different methods should prove beneficial.

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