An Intelligent System Based Approach to Accounting Choices Evaluation and Selection

Research-in-Progress

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Abstract

Accounting choices have significant impacts on companies’ accounting results which are closely monitored by managers, investors and government agencies. This paper proposes an intelligent system based approach to accounting choices evaluation and selection. The approach addresses the accounting choice decision making problem from a novel perspective. To select the most suitable accounting choice method, an artificial neural network model is developed to examine the complex interactions between operational data and accounting results. By applying intelligent and multicriteria decision making techniques, this paper takes a broader scope that is traditionally challenging in predicting and evaluating the consequence of alternative accounting methods with regard to business strategic goals. Results of a preliminary study provide new insights into accounting choice selection problems. This paper contributes to accounting choice research by proposing a new approach for filling existing gaps and providing solutions for accounting choice decision making in practical settings.

Keywords: Intelligent system, accounting choice, decision support

Introduction

Accounting choice decision making problems have been a long-standing challenge to companies, accounting professionals and academia. A narrow definition of an accounting choice is a decision of selecting a preferred accounting method from applicable methods. Each accounting choice type corresponds to a particular business function, where multiple accounting methods are applicable for selection. Whereas, accounting methods are sets of rules for how to record business transactions in financial information. For instance, inventory accounting choice is to decide among Last-in-First-out (LIFO), First-in-First-Out (FIFO) and Weighted Average, despite the physical inventory operation. Accounting is one of the essential functions of a typical business, which multiple types of accounting choices are needed.

Accounting choice decisions have significant impacts on accounting results, namely, the balance sheet, the profit and loss report and the statement of cash flow. Those results are deemed as a reflection of the company performance. As financial markets become one of the major funding sources for public traded companies in the modern business environment, accounting results substantially influence the company’s ability to raise funding. Hence, executives and accountants have to pay close attention to the accounting results, resulting from the selection of accounting choices. In current practices, accounting choice decisions are made by executives and accountants who have profound understating and
knowledge of the company, the business and accounting standards. Internal and external business factors are considered, such as capital structure and production features, industry competition and economic forecast. While these factors often change, the accounting choices used are much less reviewed and changed in response to the changing conditions. This is because accounting choice decision making is not adequately supported, due to the fact that the interactions between accounting results and consequences of accounting choices have not been clearly examined in existing studies. Additionally, conflicting conclusions are often reached due to the limitations in accounting choice research, which has not led to better understanding of this decision problem for the past 20 years (Fields et al. 2001).

The objective of this study is to propose an intelligent system based approach for two accounting choice types, with empirical data from a case company. Exploration cost accounting and inventory accounting include Full Cost (FC) method and Successful Effort (SE) method, and LIFO, FIFO and Weighted Average respectfully. These accounting methods are well defined by accounting standards. Companies are required to disclose the accounting methods applied in preparing accounting results. An intelligent system is able to examine the consequences of different accounting methods on accounting results and to evaluate decision alternatives with regard to business strategic goals. Hence, to achieve the research objective, three research questions are to be addressed. First, how to obtain accounting results for all accounting methods for a given accounting choice type? Relevant business factors and affected accounting items need to be identified, and the relationship between them need to be modelled. Second, how to evaluate and select an accounting method from applicable methods for a given accounting choice type? This requires identifying evaluation criteria, determining performance ratings and criteria weighting, and selecting aggregation ranking methods. Third, how to select a combination of accounting methods for multiple accounting choice types? To evaluate multiple accounting choice types, interacting effects of different accounting choice types need to be identified and measured for predicting accounting results.

In subsequent sections, we first review what have been achieved in accounting choice research and identify important gaps to be addressed. We then present an intelligent system based approach for addressing the research questions that fill the identified gaps in accounting choice research. To illustrate how the approach works, we conduct a preliminary study on an international leading oil and gas company. Finally, we discuss the results of the preliminary study and suggest future studies.

**Literature Review on Accounting Choice Research**

Accounting is a systematic and comprehensive approach for measuring, processing, recording and communicating companies’ operations in financial information. It is one of the most critical functions supporting internal and external decision making. Accounting choices have significant impacts on the companies’ accounting results (DeAngelo et al. 1994; Fields et al. 2001; Groot 2015). A broader definition views the accounting choices as a wide range of decisions that purposefully affect the accounting results (Fields et al. 2001). A character that can distinguish the scope of accounting choice definition is whether it is visible or invisible. There are other accounting related decisions can generally be identified as accounting choices, such as the structure of a lease, the level of financial information disclosure and the time of adopting new accounting standards. They are most unique and invisible, which are not in the scope of this study. Additionally, different types of accounting choices impact on different items on the accounting results. Different accounting methods will result in different accounting results given the same business operations. In addition to the inventory accounting choice, other types of visible accounting choices are normally needed for a typical business, such as revenue recognition, depreciation, and research and development (R&D) capitalization.

**Factors Influencing Accounting Choices**

The studies on investigating accounting choices determinants since the 1990s have not made better understanding of how to make better accounting choice decisions (Fields et al. 2001). In practice, there are many means available for managers to achieve their goals, and accounting choice research has not evolved with the increasing complexity and volatility of the business environment (Fields et al. 2001;Holthausen and Leftwich 1983). Existing studies are mainly focusing on the perspectives of (a) the agent
theory related issues, (b) the reflective hypotheses, (c) income management and (d) comprehensive frameworks for accounting choice decision making.

The agent theory concerns the CEO’s motivation and personal influences. Existing studies show that managers manipulate the accounting outcomes to serve various personal and economic purposes (Balsam 1998). Another study finds that CEOs will be less aggressive in choosing accounting methods if more tenure certainty is given. More aggressive accounting decisions that inflate company earnings would be used by new CEOs to establish the reputation or CEOs in the final year of tenure for assisting in seeking the next employer (Zhang 2010).

Whereas, the reflective hypotheses argue that CEOs are making decisions to reflect the true performance and financial situation of the companies (DeAngelo et al. 1994). With the empirical data of 260,000 observations over 50 years, a study finds that there is no strong evidence suggesting aggressive accounting choices are used to intentionally increase income (Dichev and Li 2013). Similarly, no evidence found in CEO manipulating financial reports before and after initial public offering (IPO) (Aharony et al. 1993). A study focusing on the R&D capitalization in France adds stronger evidence in supporting the accounting choice decision being made to reflect the true situation of the R&D projects (Cazavan-Jeny et al. 2011).

Moreover, income management motivations are widely investigated. A study considers accounting choices as the tools for managers to influence reported earnings and capital structure in an imperfect market (Watts and Zimmerman 1990). In contrast to the previous IPO and accounting choices study, Friedlan (1994) finds that the IPO issuers do make income increasing accounting choices by accruing more income before the IPO. Numbers of accounting choice research suggest that accounting choices are influenced by the pressure for meeting or beating the benchmark and financial analyst expectation (Gietzmann and Ireland 2005).

Finally, in recent studies, comprehensive frameworks for accounting choices decision making are proposed involving company internal factors, political factors, economic factors, financial factors, people factors and industrial factors (Groot 2015; Pierk 2014). For example, Groot (2015) suggests an iterative review process involving various objectives and constraints, including financial review, operational review, valuation review and overall review. The process assists in accounting choice decision making by reviewing whether accounting choices are made in alignment with financial objectives, whether the accounting choices should be made to adjust or retain the original operational data for the basis for recording, whether the current valuation method is appropriate and whether the potential effects of the accounting outcome to external entities are acceptable. The goal of exercising reviews is to record, measure, monitor and communicate its financial information in the way best suited to the situation of the company.

**Previous Decision Support Research on Accounting Choices and Gaps**

From the decision support perspective, early studies on accounting choices have proposed mathematical models for supporting inventory accounting decision between LIFO and FIFO for influencing the value of asset, the cost of produced goods and investor reaction to maximizes the total economic benefits to the company (Hughes and Schwartz 1988). However, other accounting choices are neglected. The complex interactions between accounting choices and other aspects of the business and increased volatility in industries and economy make the current accounting choice decision making approach increasingly ineffective. Accounting studies are often disconnected with the practice, despite some findings and insights have been contributed to the body of knowledge (Lassini et al. 2016). For instance, based on the understanding of accounting theories, different business models should adopt different accounting methods to best suit operational and strategic settings of the business. However, empirical evidences show that no significant differences in the accounting choices are made among the companies with significant different business models.

No existing study uses quantitative methods to support accounting choice decision making. It is believed that the following drawbacks exist in accounting choice research (Fields et al. 2001):
Multiple and conflicting business objectives are not considered and dealt with in the research scope. Multiple business objectives are recognized, but they are often ignored in the assumption. In addition, interacting effects and trade-offs among multiple business objectives have never been investigated.

Research questions are not effective for supporting better accounting choice decision making. Existing studies often address research questions by investigating what drives the accounting choices. Instead, it seems to be more appropriate to examine whether the accounting choices are made consistent with strategic goals.

Traditional methodologies are not sufficient. It is believed that traditional statistical techniques are insufficient for nonlinear and dynamic problems such as the investigation of the consequences of accounting choice decisions.

Multiple shortcomings need to be addressed in accounting choice research with an effective quantitative method. It is believed further research on accounting choice decision making for supporting business objectives are needed (DeAngelo et al. 1994; Fields et al. 2001; Lassini et al. 2016). To address these shortcomings, this paper proposes an intelligent system based approach.

The Intelligent System Based Approach

Figure 1 shows the intelligent system based approach which consists of two components. Machine learning components are used to produce consequent accounting results for all applicable accounting methods. Decision support components are used to evaluate and optimize the selection of accounting methods. Two components jointly help the decision maker to make comprehensive accounting choice decisions by quantifying the consequences of alternative accounting methods and evaluating the performance of alternative accounting methods in terms of business strategic goals. The two key techniques used are artificial neural networks (ANNs) and multicriteria decision making (MCDM).

Comparing to traditional statistical methods, ANNs significantly increases the accuracy of the models while it remains easy to apply in numerous business and finance problems (Tkáč and Verner 2016). Depending on the problem features, ANN applications may use different architectures, including feedforward networks, recurrent networks, adaptive resonance theory maps and competitive networks (Russell and Norvig 2003). Feedforward networks flow signal from input units to output units with signal directions. They can have multiple layers of processing neurons. Both single hidden layer and multiple hidden layer feedforward networks have been widely applied for forecasting problems as they have higher accuracy (Russell and Norvig 2003). Recurrent networks have feedback connections through bi-directional data flow between needed neurons. They are better fitted for the problems with the time series character (Aladag et al. 2009; Russell and Norvig 2003; Zhang 2001).
As the complexity of the problem increases, less theoretical understanding can be provided (Gardner and Dorling 1998). Applying ANNs in a complex and specialized domain has a number of benefits. First, it does not require assumptions about the underlying model form. Second, it is nonlinear which can be applied to complex problems. Third, it is a universal functional approximator which can be used in wide range of problems providing good prediction accuracy.

To select the most suitable accounting method for specific company settings, MCDM is used to address the rationality, effectiveness, consistency and complexity issues of the decision problem (Hwang and Yoon 1981). An MCDM problem is commonly characterized by decision alternatives, decision criteria, criteria weights and a decision matrix (Hwang and Yoon 1981; Yoon and Hwang 1995). All applicable accounting methods are the decision alternatives for the accounting choice decision problem. Multiple financial ratios that are important and relevant to the business strategic goals are the decision criteria, with respect to which performance ratings of alternative accounting methods can be obtained using the ANN predicted accounting results. Thus, a decision matrix can be obtained with performance ratings of each alternative accounting method with respect to a set of financial ratios. A criteria weighting method is used to determine the relative importance (weights) of financial ratios for achieving business strategic goals. To evaluate the overall performance of alternative accounting methods for achieving business strategic goals, an aggregation method is used to aggregate the performance ratings of alternative accounting methods and the weights of financial ratios.

Different MCDM techniques with various structures and logics have been developed to address different features and settings of the decision problems (Yeh 2003). This study will develop a new MCDM method with an optimal criteria weighting technique (Yeh and Xu 2013) to evaluate the overall performance of each alternative accounting method with respect to a set of business strategic goals.

**Preliminary Study**

To illustrate how the approach shown in Figure 1 works, a preliminary study is conducted, using an international leading oil and gas company, Eni, as the case company. We use the case company’s data to model the relationships between business factors and accounting results that are relevant to exploration accounting via supervised training. First, to identify internal and external factors that are relevant to oil reserve exploration activities, we refer to the accounting choice literature and analysis reports from the case company and relevant accounting firms. Second, accounting items that are influenced by different accounting methods are identified. As shown in Table 1 and Figure 2, 15 operational data are selected and used as 8 ANN inputs. Six accounting results are identified as ANN outputs for supervised training, as shown in Figure 2. These accounting results are the total asset (A1), total liability (A2), total equity (A3), net sale from operation (A4), operation profit (A5), and net profit attributed to shareholders (A6).

### Table 1. Operational Data and ANN Inputs

<table>
<thead>
<tr>
<th>Operational Data</th>
<th>ANN Inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reserves volume: liquids, natural gas, hydrocarbons</td>
<td>R1: Reserve</td>
</tr>
<tr>
<td>Production volume: liquids, natural gas, hydrocarbons</td>
<td>R2: Production</td>
</tr>
<tr>
<td>Number of employees</td>
<td>R3: Organization size</td>
</tr>
<tr>
<td>Share price, traded volume</td>
<td>R4: Company share effect</td>
</tr>
<tr>
<td>Interest rate for USD and EUR</td>
<td>R5: Interest rate</td>
</tr>
<tr>
<td>Exchange rate for USD/EUR</td>
<td>R6: Exchange rate</td>
</tr>
<tr>
<td>Future price, traded volume</td>
<td>R7: Oil commodity effect</td>
</tr>
<tr>
<td>Full Cost (0), Successful Effort (1)</td>
<td>R8: Accounting choice</td>
</tr>
</tbody>
</table>

Figure 2 shows the ANN model for predicting accounting results based on a company’s operational data and a specific accounting method. The hidden layers of the ANN model can be structured differently to
implement different ANN structures. The relevant company data are collected and reorganized from Eni’s annual report, 20-F fillings and factbook from publicly available documents. The data for external factors are sourced from Yahoo finance and the economic research data repository of Federal Reserve Bank of St. Louis for shares data, commodity data and interest rates. The dataset consists of 45 sets of quarterly data from the 4th quarter of 2005 to the 4th quarter of 2016.

The data scales for different variables are quite distanced. We apply three different scaling methods to test the model performance, including standard score normalization, feature scaling normalization and decimal scaling. To measure the accuracy of the model predictions, as having multiple ANN outputs, we use the minimum average error (MAE) which is the averaged value of each output variables’ sum of squared error. The test results show that decimal scaling outperforms others. As a result, the experimental results reported are thus based on the decimal scaled data. Having 20% of the dataset for testing, controlled experiments and tests of four architectures are conducted using optimized ANN training parameters. Using both single and two hidden layers feedforward networks, after 70,000 learning epochs, the results suggest that having the accounting choice variables (R8) improves the performance of the model, as shown in Table 2.

Table 2. Model MAE Performance with and without R8

<table>
<thead>
<tr>
<th>ANN Structure</th>
<th>With R8</th>
<th>Without R8</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 hidden layer</td>
<td>Training</td>
<td>0.0000815</td>
<td>0.0000874</td>
</tr>
<tr>
<td></td>
<td>Testing</td>
<td>0.0003935</td>
<td>0.0004080</td>
</tr>
<tr>
<td>2 hidden layers</td>
<td>Training</td>
<td>0.0001018</td>
<td>0.0000977</td>
</tr>
<tr>
<td></td>
<td>Testing</td>
<td>0.0004246</td>
<td>0.0004328</td>
</tr>
</tbody>
</table>
Using all four ANN architectures, Table 3 shows that recurrent networks perform the best for both training and testing as the problem features time series data set.

<table>
<thead>
<tr>
<th>Business</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
<th>R7</th>
<th>R8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Contribution</td>
<td>0.28</td>
<td>0.16</td>
<td>0.41</td>
<td>0.28</td>
<td>0.6</td>
<td>0.275</td>
<td>0.51</td>
<td>0.27</td>
</tr>
</tbody>
</table>

To identify the most influential factors to the overall accounting results, we conduct a relative contribution analysis for 8 ANN inputs by measuring the relative importance of each variable in predicting the ANN’s output. As shown in Table 4, based on the trained recurrent ANN, the effects of commodity (R7) and interest (R5) have twice the impacts of other business factors on the overall accounting results. This quantitative results are consistent with the qualitative conclusion made by Eni’s analysis and accounting firms for oil and gas industry (PwC 2017). It is noteworthy to mention a new finding that the contribution of the accounting choice (R8) is as significant as other business factors, such as oil reserves (R1), production (R2) and effects of shares (R4). The relative contribution of the company size (R3) is 0.41, which is significant enough as compared with other factors. This result supports the notion that the company size should be considered in accounting choice decision making, which has been debated and criticized (Christie 1990; Fields et al. 2001).

<table>
<thead>
<tr>
<th>Business Factors</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
<th>R7</th>
<th>R8</th>
</tr>
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<td>0.27</td>
</tr>
</tbody>
</table>

Conclusion

Accounting choice decision problems are considered crucial and complex. No existing methods are available for examining the consequences of alternative accounting methods on accounting results. Hence, the practitioners are lacking in adjusting accounting choices to respond to the change of business factors. To fill the identified gaps in accounting choice research and to address the problem from a novel perspective, this paper has proposed an intelligent system based approach for examining the consequences of alternative accounting methods with quantitative evidence. The results of a preliminary study on the ANN model built suggest that the approach is effective in predicting accounting results for alternative accounting methods that have not been applied by the case company for the time period. We will also develop an MCDM model with optimal criteria weighting to evaluate the overall performance of each alternative accounting choice method with respect to business strategic goals. For multiple accounting choice types, we will develop an optimization based approach for selecting the best combination of accounting methods, while considering interacting effects of accounting choice types. Although the proposed intelligent system based approach is applied to the case company as an illustration, it can be applied to other companies and industries with their own operational and accounting data and business strategic goals. As a practical solution, it can be used to help practitioners to make rational accounting choice decisions.

References


