Expert Systems with Applications 37 (2010) 6510–6514

Contents lists available at ScienceDirect

Expert Systems with Applications

journal homepage: www.elsevier.com/locate/eswa

A rule extraction based approach in predicting derivative use for financial risk hedging by construction companies

Jieh-Haur Chen [a,*], Li-Ren Yang [b], Mu-Chun Su [c], Jia-Zheng Lin [a]

[a] Institute of Construction Engineering and Management, National Central University, Jhongli, Taoyuan 32001, Taiwan
[b] Department of Business Administration, Tamkang University, Tamsui, Taipei 25137, Taiwan
[c] Department of Computer Science and Information Engineering, National Central University, Jhongli, Taoyuan 32001, Taiwan

ARTICLE INFO

Keywords:
Fuzzy
ANN
Rule extraction
Derivatives
Financial risk
Risk hedging
Construction management

ABSTRACT

Prevention of financial risk is one of the major tasks that construction companies have to pay attention to. Using derivatives to avoid such risks is a practical strategy, but is heavily dependent on the traders' skills and accuracy of predictions. The purpose of this study is to develop an automatic expert model using a rule extraction based approach that provides practitioners with a prediction tool for the hedging of financial risks through the use of derivatives. Data for the study include 780 quarterly financial statements collected from 2002 to 2006, based on public information from 39 listed construction companies in Taiwan. Statements with incomplete and missing data are eliminated, leaving 672 with which to construct the rule extraction based model, the Hyper Rectangular Composite Neural Networks (HRCNNs). After factor dimension reduction, only 16 financial ratios out of all revealed ratios are left to be used as input variables. The HRCNNs yield an 80.6% successful classification rate. With these 16 financial ratios and the proposed model, derivative use to hedge financial risk can be established for the benefit of the construction practitioners.

1. Introduction

It is well-known that safeguarding against financial risk is a critical factor in company success. Such risks can often be serious enough to drive a construction company to distress or even bankruptcy. They can increase a firm's financial costs and can lead to a financial crisis, and typically take place due to the use of financial tool, fluctuations of currency exchange rates, interest rates, and so on. Since the entry of Taiwan into the World Trade Organization (WTO) in 2002, the Taiwan construction industry has had to face more challenges about how to lower and even hedge these risks.

Scholars suggest that, in a market facing possible high inflation and global competition, ways to safeguard against financial risk cannot be neglected (Battermann & Broll, 2001). This is particularly true of the situation in the Taiwan construction market. There are numerous financial techniques for dealing with financial risks (Ross, Westerfield, & Jaffe, 2002). One recently developed alternative, derivatives for financial risk management, has proven popular and effective but is heavily reliant on expert knowledge for its success (Besley, 1995; Lessard, 1995). Thus, it is inappropriate for small- to medium-sized businesses where it is not possible to hire experienced experts to handle financial risk hedging. Such small-sized companies make up 83.7% of the total number of construction companies in Taiwan (Chen, Yang, Chen, & Chang, 2008). Although studies have shown that derivative use can lower financial risk, its successful use for risk hedging is really experience-oriented, requiring the knowledge of financial specialists (Geczy, Minton, & Schrand, 1997). An effective and objective solution for the resolution of this dilemma can be an automatic expert model that is capable of predicting whether a company should apply derivatives for financial risk hedging given its current financial status.

In this study, a rule extraction based approach, the Hyper Rectangular Composite Neural Networks (HRCNNs), is used to establish an expert model capable of predicting derivative use for financial risk hedging. The prediction is performed on the basis of the current financial status of a construction company. Data are utilized from all listed construction companies in Taiwan that publicly reveal their financial status. This includes 39 construction and construction related companies. There are 20 financial ratios revealed in the financial statements including: debt to assets ratio, long-term fund to fixed assets ratio, current ratio, acid-test ratio, times interest earned ratio, receivable turnover ratio, days sales outstanding, inventory turnover ratio, days sales of inventory, fixed asset turnover ratio, total assets turnover ratio, return on assets, return on equity, operating income to capital stock ratio, profit before tax to capital stock ratio, profit margin, earnings per share, current cash debt coverage ratio, cash flow adequacy ration, and cash flow reinvestment ratio. To preserve data integrity for the

* Corresponding author. Tel.: +886 3 4227151x34112; fax: +886 3 4257092.
E-mail address: jhchen@ncu.edu.tw (J.-H. Chen).

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doi:10.1016/j.eswa.2010.02.135

calculation of the ratios, all quarterly financial reports of these 39 companies from 2002 to 2006 are included, that is, 780 quarterly statements.

2. Derivatives toward financial risk hedging

The derivatives, including forwards, futures, swaps, and options, are commonly used for four major purposes: hedging risks, speculating, arbitrating price differences, and adjusting portfolios. Empirical evidence on the use of derivatives by corporations has been collected and discussed (Berkman & Bradbury, 1996; Dolde, 1993; Nance, Smith, & Smithson, 1993). Dolde pointed out that since 1993, 85% of the Fortune 500 firms have used derivatives (Dolde, 1993). Nguyen and Faff further stated that over the last decade there has been significant derivative use by corporations around the world (Nguyen & Faff, 2002). Studies and applications related to risk hedging, speculating, price arbitrating, and portfolio adjusting are also numerous. Practitioners perform currency risk hedging through the use of futures and forwards (Lioui, 1998). This hedging can lower underinvestment costs because of financial constraints (Geczy et al., 1997). It has been concluded that numerous non-financial firms in both the US and Germany have made use of derivatives to manage risks arising from fluctuating financial prices. Derivative use are dependent on specific corporate business activities and characteristics (Bodnar & Gebhardt, 1999). Bailly et al. surveyed the utilization of derivative practices for hedging purposes by non-financial firms in the UK. They confirmed that a high percentage of firms consider derivative activity to be an important hedging tool (Bailly, Browne, Hicks, & Skerrat, 2003). The number of recent studies associated with risk management and hedging is growing (Barria & Hall, 2002; Mallin, Ow-yong, & Reynolds, 2001; Panayides, 2006; Prevost, Rose, & Miller, 2000; Sheng, 2005). Nevertheless, construction related industries in Taiwan (such as the real estate industry) only began to make use of derivatives for risk management in the last decade of the 20th century. The weather derivative concept has lately been introduced to construction companies. A company can apply derivatives such as call options, put options or collars to prevent financial loss due to severe weather (Holmes, 2004). It has been found that a company which carries a relatively large amount of debt is more likely to consider derivative use, since there exist substantial entry costs for hedging financial distress. It has also been proven that although derivative use can be efficient in terms of managing financial risks it may be costly (Horng & Wei, 1999). Most evidence and theories suggest that the use of derivatives for risk hedging is a feasible and effective way to safeguard against financial risk. For those construction related companies which are sensitive to currency and interest rates, financial risk hedging by derivative use is encouraged.

3. Fuzzy and neural network approaches in construction

Fuzzy and neural network approaches have been applied in the engineering field for decades. There are a wide number of approaches used for prediction in numerous engineering related areas such as earthquake prediction, stream flow prediction, traffic flow prediction, loading prediction, and so on (Chang & Chen, 2001; Fu, Li, & Xie, 2006; Wang et al., 1997; Yin, Wong, Xu, & Wong, 2002). There are also numerous studies on construction management issues where fuzzy and neural network approaches are used for cost estimation, contractor selection, scheduling, budgeting, performance and quality forecasting (Yeon, Kim, & Jun, 2008). Neural network models can provide percentage changes in expected cost based on three key factors, environment, company, and project. The method can be used to estimate the percentage increase in costs for typical highway projects (Al-Tabtabai, Alex, & Tantash, 1999). The neurofuzzy approach is a feasible way of dealing with quantitative measurement, as proven by two neural network models for construction budget and schedule using fuzzy data. Model predictions can assist project management to make the proper allocation of available resources (Chua, Kog, & Loh, 2001). Contractor prequalification can be quantified using a neurofuzzy approach. Such method improves the objectiveness of the contractor prequalification (Bendana, Del Cano, & De La Cruz, 2008; Georgy, Chang, & Zhang, 2005; Lam, Hu, Nq, Skitmore, & Cheoung, 2001). Fuzzy and neural network methods have demonstrated their practicability in risk management. A neural network approach has been used to assess environmental risks for construction projects. It is a useful tool for officials to evaluate the impact of environment risks on construction projects in heavily developed urban areas (Maria-Sanchez, 2004). In another study, a fuzzy decision framework was used to evaluate the global risk factors affecting construction cost performance on a project level (Baloi & Price, 2003). In 2005, neural networks were utilized to predict the risk of contractor default (Al-Sobiei, Arditi, & Polat, 2005). A fuzzy based decision making model was introduced to provide construction project management an alternative for risk management (Zeng, An, & Smith, 2007). However, until recently, there have been few studies of the use of neurofuzzy models related to engineering finance. Bekiro investigated the forecasting ability of the neurofuzzy models related to trading strategies for higher profitability (Bekiros, 2007). Many of the above types of model have been developed in the last few decades. Neurofuzzy models have potential for involvement in construction, especially for solving problems associated with pattern classification.

4. Data collection and analysis

Corporate financial statements reveal information needed for risk hedging by using derivatives. Each financial statement clearly records whether the listed company uses derivatives to perform risk hedging and what derivative(s) the company uses. This confirms the suitability of financial statements as an ideal data resource for this study. Acquisition of financial statements from relatively small firms is more difficult. Moreover, the use of derivatives to hedge financial risks is not efficient for small companies, since the costs incurred are usually greater than the impact of the risks. Considerations of accessibility and risk-hedging practicability limited our data collection targets to listed construction related companies in Taiwan. There were 39 listed companies related to the construction business. The Taiwan stock exchange center requests quarterly financial statements for all listed firms, revealing a total of 20 financial ratios. The appropriate collection period was set to be 5 years because of the computation requirement for the ratios. About 780 statements from 2002 to 2006 were collected. Approximately half of the companies are currently using or have used derivatives as a tool to hedge financial risks. After eliminating incomplete and missing data, a total of 672 statements are left to serve as input data. The 20 ratios are set as input variables. However, 4 of the 20 ratios are deleted because of doubtful entries. The 16 remaining ratios are the debt to assets ratio, long-term fund to fixed assets ratio, current ratio, acid-test ratio, times interest earned ratio, receivable turnover ratio, total assets turnover ratio, return on assets, return on equity, operating income to capital stock ratio, profit before tax to capital stock ratio, profit margin, earnings per share, current cash debt coverage ratio, cash flow adequacy ratio, and cash flow reinvestment ratio.

The formulas for computation of the 16 ratios are given in Table 1. The first two ratios are usually used to present the capital structure of the corresponding company. The financial positions are related to the liabilities and equity which comprise the capital