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*Full Length Research Paper*

# Detecting firms with going-concern risk based on the industry affiliation, corporate governance characteristics, and financial performance

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**Detecting firms with going-concern risk is precisely critical to all financial professionals. The analytical features included three aspects: the industry domain, the corporate governance characteristics, and the financial performance. An enhanced two-step analytical approach was developed in this study. First, the multivariate analysis (MA) applied to explore influential factors affected the uncertain behaviors of a firm. Secondly, with the prioritized significant factors identified in MA model, the classification and regression tree (CART) technique was adopted to generate decision tree. There were nine significant factors: size of the board of directors, percentage of independent directors, ratio of shares pledged, family-owned type, ratio of cash right deviation, hiring Big 4 CPA firms, earnings per share, debt ratio, and return on assets. These practical finding provides comprehensive understandings of the behaviors of the firms with C-G risks. Weighing from the decision tree modeling, the testing results showed 87.5% successful rate which demonstrated itself as an effective and analytical tool and will suffice the practical needs for detecting firms with going-concern risk. .**

**Key words:** Going-concern, industry affiliation, corporate governance, financial performance, multivariate analysis, classification and regression tree (CART), decision tree.

## INTRODUCTION

Detecting firms with going-concern risk (G-C) as precise as possible is critical to stock holders and professional investors. A firm with going-concern refers to its ability to make enough money to stay afloat or avoid bankruptcy or delisted. Ferris et al. (2007) reported that the ratio of involuntary delisting firms in the Asia-Pacific region between 1980 and 1999 is 17.4% in Thailand, 10% in Malaysia, 9.7% in Taiwan, 7.8% in Singapore, 7.3% in Indonesia, 5.5% in South Korea, 5.2% in Hong Kong, and 2.4% in Japan. From the global point of view, Dahiya and Klapper (2007) indicated that between 1994 and 2003, United States has the highest average annual involuntary delisting rate as 6.78%, followed by 5.65% in United Kingdom, 4.57% in France, 3.45% in Australia, 3.39% in Canada, 2.85% in Germany, and 1.05% in Japan. In order to explore more detailed and comprehensive information about the firms with G-C risk, the analytical features should include at least three solid aspects: the industry domain specialties of the company, the corporate governance characteristics of the managerial level, and the fundamental financial achievement.

Block (2005) showed that the capital budgeting behavior of 320 sample companies with different industry affiliation patterns from Fortune 1000 demonstrated significant differences in their financial and capital budgeting decisions. Banko et al. (2006) investigated the relationship between the value effect and industry affiliation. Fifteen out of twenty-one industries, ranging from communications, services, to primary metals, showed that the value effect was a significant premium factor among different industry affiliations in diverse stages.

Kiymaz (2006) found out that divesting and acquiring firms have significant difference in wealth gains with

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respect to industry affiliation. In other word, firms from dissimilar industries will demonstrate diversified business



and financial behaviors. However, this important industry affiliation factor was seldom discussed by the previous researchers while investigating firms with G-C in doubt.

The corporate governance (CG) characteristics also affect the problematic status of a firm (Ning et al., 2007; Abdullah, 2006; Chen et al., 2006). Uzun et al. (2004) pointed out that the CG practice is the competent functioning of outside directors and independent supervisors in the board of director (BOD).

From the independent CG factors being explored, Charitou et al. (2007) identified that the effectiveness of a firm's corporate governance mechanism, for example, the structure of its BOD and ownership incentives, are highly related to its ability to get survived in the market. Similar findings about the BOD structure and ownership were also discovered by Shen et al. (2006), Agrawal and Chadha (2005), and Igor et al. (2005). Aside from the factors of industry affiliation and CG characteristics, firm performance related factors, such as sales, profitability, leverage, total asset, total equity, cash flows, and interest coverage were also explored by Dahiya and Klapper (2007), Marosi and Massoud (2007), Ning et al. (2007), Barontini and Caprio (2006), Ben-Amar and Andre (2006), Bruwer and Hamman (2006), and Agrawal and Chadha (2005).

As far as the analytical methods adopted to explore the factors that affect a firm with G-C risk status, multivariate analysis (MA) technique is one of the most popular methods. Canbas et al. (2006) applied multivariate analysis of variance procedure (MANOVA) to predict the financial distress behavior of firms in Istanbul Stock Exchange.

Lim et al. (2007) used MANOVA to identify the close association between board composition and the voluntary disclosure information. Same analytical tool was also adopted by Patelli and Prencipe (2007) to research the classical agency problem. Other than filtering out the significant causes, an intuitive tool in predicting the binary decision results with the recursive regression method, namely the CART technique, has become popular in recent years.

Sun et al. (2002) created a CART model to cluster stock market events related to the massive delisting of Singapore and Malaysia between 1989 and 1998. Similarly, Bruwer and Hamman (2006) applied CART technique to develop a prediction model for cash flow failure companies in South Africa.

The objective of this paper is twofold. First, firms with G-C risk in different industries and healthy firms with similar business profiles between 2000 and 2008 are extracted from Taiwan Stock Exchange (TSE) and Gre Tai Securities Market for over-the-counter market (GTSM-OTC) databases, respectively. Secondly, an enhanced two-step analytical approach is proposed to detect firms with G-C risk: 1) the multivariate analysis (MA) procedure is applied to identify the significant factors for the problematic status of a firm from the industry affiliation, CG, and financial performance aspects and 2) in order to improve the decision making efficiency in practice, only those significant factors are incorporated into the CART model to detect the resultant status of the target firm.

## FACTORS INVOLVED IN INDUSTRY AFFILIATION, CORPORATE GOVERNANCE, AND FINANCIAL PERFORMANCE

The first category of interested factors in affecting firm with G-C risk status is its industry affiliation. Kavussanos et al. (2002) examined 38 international industry sectors from the Morgan Stanley Capital International (MSCI) using a multi-factor time series model. The results showed that there are significant relationship among different industry sectors and stock returns.

The industry classification of given asset become crucial, as certain global industries develop to be homogeneous, and capital markets are becoming increasingly integrated. Watanabe and Jae (2004) analyzed 24 Japan's electrical machinery firm's financial performance. They found out that the marginal productivity of technology based on the total factor productivity and R and D intensity is essential to Japan's service-oriented society.

Liu and Hsu (2006) concluded that the manufacturing firms in Taiwan with different industry affiliations, for example, traditional industry, basic industry, and technology-intensive industry, will have significantly different financial structures and financing patterns.

The central ideology of CG is to develop a protective agent mechanism that can separate corporate management and finance (Chuanrommanee and Swierczek, 2007). How to assure that the investors have a fair return from their investment is the core challenge of this agent mechanism. The contents of CG include the appropriate performing of the rights and responsibilities of shareholders, banking regulations, ethical practices, corporate board of director, and financial institution's transparency. CG concerns not only the managers and shareholders, but also the controlling and minority shareholders, respectively. It is needless to address that the failed fulfillment of CG will cause the firms delisting eventually.

According to the annual report from Securities and Future Institute (SFI-Taiwan, 2007), inadequate corporate governance system has been concluded as the major reason suffering the serious consequences on the 1997 to 1998 Asian financial crises. Firms with G-C in doubt are classified into twelve conditions, and corrective actions and amendments of regulations were taken to ensure the integrity of the securities market.

The CG related factors have been identified as influential effects to the problematic/healthy status of a firm in various literatures. Ning et al. (2007) examined effects of the ratio of independent directors, staggered

board, number of board committees, CEO's age, CEO's duality, CEO involved in director selection, and new CEO in the US stock market. Abdullah (2006) investigated the percentage of independent directors, duality of board chairman and CEO, shares held by executive and non-executive directors, respectively. Marosi and Massoud (2007) adopted the insider ownership, that is, the ratio of holdings of common (voting) shares by all directors and officers to the total outstanding (voting) shares, as one of the evaluation factor. Similarly, Charitou et al. (2007) showed that the structure of BOD, for example, the ratio of outside directors served on the board, number of directors served on the board, number of board meetings during the monitoring period, and voting power owned by officers and directors as a group, are related to the problematic results.

Shen et al. (2006) studied the BOD ownership factors and concluded that the controlling shareholders also responsible for running the firm, higher institutional share-holder ratio, and higher BOD and supervisor ownership tended to increase the firm's market value and hence reduce the problematic possibility in Taiwan TSE and OTC market.

Besides the CG factors, the financial performances were also identified as the fundamental factors to the problematic status of a firm traditionally. The most recent evidences were obtained by various researchers. Charitou et al. (2007) suggested that the problematic phenomenon is arisen from both the board features and the operational figures. Marosi and Massoud (2007) found that firms with fewer valuable growth opportunities, higher leverage, and lower market momentum were more likely to go dark.

Ning et al. (2007) identified that the total asset, return on asset, and total debt to asset were significant to problematic firms. Other researches attempting at predicting either financial distress, bankruptcy or delisting status of a firm based on ex post financial information were: Branch (2002), Maurice (2007), and Muller and Steyn-Bruwer (2009).

## METHODOLOGY

### Sample selection and data preparation

The sample selection and data preparation in this paper contains two stages. The first stage is to extract sample data of firms with G-C risk and the associated matched healthy firms during the same occurrence year. The data set prepared for this paper contains 115 firms with G-C risk confirmed from the TSE and GTSM-OTC during 2000 to 2008, and then the related data information is extracted from Taiwan Economic Journal (TEJ) database. Based on the distribution of their industry affiliations, 86 firms belong to the manufacturing industry and 29 firms belong to the service industry, respectively.

In order to verify the detailed problematic reasons for the firms with G-C risk, public financial news were also examined based on two other well known databases: 1) China Times News Search and Knowledge Base Joint News Retrieval and 2) the official website of Public Information Observatory. Based on the corresponding years and industry affiliations, 87 counterpart healthy firms with similar company profile, that is, 61 manufacturing firms and 26 service firms, were also extracted from TSE, GTSM-OTC, and TEJ.

The second stage of preparing the illustrative statistical model is to extract the associated twelve variables for the targeting firms. The model indicator (dependent variable) is the status of a firm either with G-C risk or healthy. The independent variables include three categories: the first one is the industry affiliation variable, which is, either manufacturing or service industry. The second one is related to corporate governance (CG) characteristics: 1) the size of BOD, 2) the percentage of independent directors in BOD, 3) the duality of the chairman of BOD who is also the CEO of the firm, 4) the ratio of the total pledged shares to the total on-hand shares of the BOD and supervisors, 5) the final controller group (that is, a family group) at the end of year holds shares in the BOD exceeding 50% of the total shares in BOD, 6) ratio of the right of seat over the right of control, 7) ratio of the right for cash flow over the right of control, and 8) external auditing agency belongs to Big 4 CPA firms. The third one adopts the firm financial performance: 1) earnings per share, 2) ratio of total liabilities to total assets, and 3) return on total assets. The associated abbreviations for the variables are provided in Table 1. After the procedure, the enhanced two-step detective approach is then invoked to develop the analytical procedure to identify further targeting firms.

## MODEL DEVELOPMENT AND DATA ANALYSIS

The enhanced approach for detecting firms with G-C risks contains two steps. The first step applies the multi-variate analysis (MA) procedure to disclose the significant factors among the problematic status of targeting firms with different industry affiliations factor, corporate gover-nance (CG) factors, and financial performance factors. Only the significant factors identified from the MA model will then be adopted in the next step to improve the decision making efficiency. The second step adopts an enhanced intelligent CART technique to generate a set of decision rules based on the prioritized significant factors which is more intuitively-sound to detect the problematic status for firms from different industry affiliation clusters. The detailed procedures are depicted further.

### Step 1: Development of the multivariate analysis model

Multivariate analysis (MA) is commonly used to predict the interaction and association among a set of dependent and independent variables in a complex problem domain. Also, MA can identify significant effects of the dependent variables while changing the value of independent variables. The MA model contains two conditional steps: the first step is to test the effects of all 12 variables to the entire sampling dataset which contains all 202 firms (115 problematic plus 87 healthy firms) affiliated with either manufacturing or service industries. Table 2 shows that the Wilks' lambda statistic is significant (p=0.000) which represents that the 12 dependent variables have overall significant effect to the firms With G-C risk status

(STATUS) in the mixed industries model. With this finding, further MA models for the individual manufacturing industry and the service industry are developed,



**Table 1.** Definitions of dependent and independent variables.

| Variable | Definition |
|---|---|
| **Outcome variable** | |
| STATUS | "with G-C" for a firm's operation has a doubt of going concern, and "healthy" for normal operating firms |
| **Independent variable** | |
| Industry affiliations | |
| Affiliation | The industry affiliation, "manufacturing" or "service" |
| **Corporate governance** | |
| BDSIZE | The size of directors on the board |
| Independent | Percentage of independent directors in BOD |
| DUAL | 1, if the chair of the board is also the CEO, and 0 otherwise |
| PLE | The ratio of the total pledged shares to the total on-hand shares of the BOD and supervisors |
| FAMILY | 1, if the final controller group (that is, a family group) at the end of year hold shares in the BOD exceed 50% of the total shares in BOD, 0 otherwise |
| SEATCON | Ratio of the right of seating over the right of control |
| CASHCON | Ratio of the right for cash flow over the right of control |
| BIG4 | 1, if the external auditing agency belongs to Big 4 CPA firms, and 0 otherwise |
| **Financial performance** | |
| EPS | Earnings per share |
| DEBTRATIO | Ratio of total liabilities to total assets |
| ROA | Return on total assets |

respectively. Table 3 shows the general descriptive statistics. The detailed analysis of the MA models results is given thus (Table 4):

### *The complete MA model*

Majority of the CG related variables reveal significant effects to the with G-C risk status of firms. The firms with G-C tend to have: 1) less size of BOD (BDSIZE, $p$=0.000, B=-2.031), 2) smaller percentage of independent directors in BOD (INDEPENDENT, $p$=0.000, B=-0.11), 3) higher ratio of the total pledged shares to the total on-hand shares of the BOD and supervisors (PLE, $p$=0.000, B=26.111), 4) less ratio that the final controller group (that is, a family group) at the end of year hold shares in the BOD exceed 50% of the total shares in BOD (FAMILY, $p$=0.000, B=-0.247), 5) higher ratio of the right of seating over the right of control (SEATCON, $p$=0.000, B=22.284), and 6) less hiring percentage of the external auditing agency that belongs to Big 4 CPA firms (BIG4, $p$=0.001, B=-0.228), than the healthy firms. From the financial performance point of view, all of the three variables demonstrate significant effects to the with G-C status of firms (all $p$=0.000): the with G-C firms, regardless their industry affiliations, have 1) poorer earnings per share (EPS, B=-4.022), 2) higher ratio of total liabilities to total assets (DEBTRATIO, B=78.191), and 3) less return on total assets (ROA, B=-17.108).The PLE test result matches with the general rule of thumb in the stock market that if the BOD members pledged significant percent of their shares, the firms tends to go dark (Marosi and Massoud, 2007, Charitou et al., 2007, Dahiya and Klapper, 2007).

The insignificant effect that the duality of the chairman of BOD is also the CEO of the firm (DUAL, $p$=0.831) is consistent with prior literatures (Sharma, 2004, and Chen et al., 2006). The FAMILY test result conforms to Taiwan's environment that majority of the firms are "family-owned" and there is strongly significant likelihood that a firm will have going concern risk if the firm is family-owned. The SEATCON test result also confirms that if BOD members' right of seating is significantly higher than the right of voting will jeopardize the operations of the firm thus increase the likelihood of G-C. The results on the control variables suggest firms with G-C are smaller, with fewer growth opportunities, lower leverage, and poorer operating performance.

### *The MA model for the manufacturing industry firms*

For firms in manufacturing industry cluster, six out of eight corporate governance (CG) factors are significant and all three financial performance related factors are significant to the targeting firms. The significant CG factors include:

BDSIZE ($p$=0.000, B=-2.358), INDEPENDENT ($p$=0.000, B=-0.119), PLE ($p$=0.000, B=27.613), FAMILY ($p$=0.001, B=-0.278), SEATCON ($p$=0.000, B=26.128), and BIG4 ($p$=0.019, B=-0.193). The financial performance related

**Table 2.** Multivariate tests (a, c).

| MANOVA / Model | | Complete model (manufacturing, service) | | | | | Manufacturing industry only | | | | | Service industry only | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Effect** | | **Value** | **F** | **Hyp df (d)** | **Er df(e)** | **Sig.** | **Value** | **F** | **Hyp df (d)** | **Er df(e)** | **Sig.** | **Value** | **F** | **Hyp df (d)** | **Er df(e)** | **Sig.** |
| Intercept | Pillai's Trace | 0.978 | 636.605(b) | 12 | 188 | 0.000 | 0.978 | 491.983(b) | 11 | 134 | 0.000 | 0.981 | 176.618(b) | 11 | 42 | 0.000 |
| | Wilks' Lambda | 0.022 | 636.605(b) | 12 | 188 | 0.000 | 0.022 | 491.983(b) | 11 | 134 | 0.000 | 0.019 | 176.618(b) | 11 | 42 | 0.000 |
| | Hotelling's Trace | 44.021 | 636.605(b) | 12 | 188 | 0.000 | 44.058 | 491.983(b) | 11 | 134 | 0.000 | 50.462 | 176.618(b) | 11 | 42 | 0.000 |
| STATUS | Pillai's Trace | 0.53 | 16.280(b) | 12 | 188 | 0.000 | 0.549 | 13.568(b) | 11 | 134 | 0.000 | 0.545 | 4.194(b) | 11 | 42 | 0.000 |
| | Wilks' Lambda | 0.47 | 16.280(b) | 12 | 188 | 0.000 | 0.451 | 13.568(b) | 11 | 134 | 0.000 | 0.455 | 4.194(b) | 11 | 42 | 0.000 |
| | Hotelling's Trace | 1.126 | 16.280(b) | 12 | 188 | 0.000 | 1.215 | 13.568(b) | 11 | 134 | 0.000 | 1.198 | 4.194(b) | 11 | 42 | 0.000 |

(a): Confidence level = .05, (b): Exact statistic, (c): Design: Intercept+STATUS, (d) Hypothesis dof, (e) Error dof.

factors are:

EPS ($p$=0.000, B=-4.253), DEBTRATIO ($p$=0.000, B=81.234), and ROA ($p$=0.000, B=-17.129). Only two factors do not have the impact power on the firms with going concern:

The chair of the board is also the CEO (DUAL, $p$=0.332, B=0.079) and the ratio of the right for cash flow over the right of control (CASHCON, $p$=0.801, B=0.997).

### *The MA model for the service industry firms*

Comparing MA model for the complete and the manufacturing-industry-only model, the service industry firms demonstrate less significant effects. The significant CG related factors are:

BDSIZE ($p$=0.035, B=-1.174), INDEPENDENT ($p$=0.025, B=-0.086), PLE ($p$=0.005, B=21.843), and BIG4 ($p$=0.013, B=-0.298). All of the three financial performance related factors are significant: EPS ($p$=0.003, B=-3.404), DEBTRATIO ($p$=0.020, B=69.660), and ROA ($p$=0.015, B=-17.676). Like the manufacturing-industry-only mo-del, DUAL ($p$=0.0.257, B=-0.151) and CASHCON ($p$=0.563, B=-4.618), these two factors are not significant to the targeting firms, plus, FAMILY ($p$=0.245, B=-0.159) and SEATCON ($p$=0.155, B=11.091) do not show the effect either.

### Step 2: Construction of CART decision tree to detect firms with G-C risks in different industry affiliations

The second step proposed incorporates only factors having significant effects to the firms with G-C risk status into the CART decision tree generation procedure.

The decision tree approach has been widely used in decision making situation which applies logical inference mechanism and finally provides fast and intuitive results.

In certain cases, the suggestion to the decision maker can be “probably” rather than “exact” (Spiech, 2008).

Situations such as predicting whether a firm is about going to dark, estimating the financial status of a firm is distressed, or analyzing the results of annual external auditing evaluation, the outcome is always categorical, for example, healthy or problematic, normal or distressed or, qualified or unqualified.

Under this circumstance, the application of decision rule to help making decisions in evaluating a firm’s health in the stock market thus becomes more practical and easy to use.

A classification tree is a set of inductive rules for predicting the class of the targeting object from the value of predictor variables.

The decision classification problem is composed of four components: the first component is the categorical outcome.

The second component is a set of independent variables which are the characteristics related to the outcome.

The third component is the training data set that includes both known outcome and the corresponding predictors’ values.

The fourth component is the test dataset which is used as the targeting data to be predicted (Lewis, 2000).

In short, the CART modeling technique is a non-parametric statistical approach which performs in particularly, binary recursive partitioning of the

**Table 3.** Descriptive statistics of three multivariate analysis models.

| MANOVA / Model | | | Complete model (manufacturing, service) | | | Manufacturing industry only | | | Service industry only | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variable categories** | **Dependent variables** | **STATUS** | **Mean** | **Std. dev.** | **N** | **Mean** | **Std. dev.** | **N** | **Mean** | **Std. dev.** | **N** |
| Industry affiliation | AFFILIATION | With G-C | 0.75 | 0.436 | 115 | | | | | | |
| | | Healthy | 0.7 | 0.46 | 87 | | | | | | |
| | | Total | 0.73 | 0.446 | 202 | | | | | | |
| Corporate governance | BDSIZE | With G-C | 6.74 | 2.366 | 115 | 6.59 | 2.403 | 86 | 7.17 | 2.237 | 29 |
| | | Healthy | 8.77 | 1.998 | 87 | 8.95 | 2.093 | 61 | 8.35 | 1.719 | 26 |
| | | Total | 7.61 | 2.429 | 202 | 7.57 | 2.554 | 147 | 7.73 | 2.077 | 55 |
| | INDEPENDENT | With G-C | 0.03 | 0.093 | 115 | 0.02 | 0.086 | 86 | 0.04 | 0.111 | 29 |
| | | Healthy | 0.14 | 0.159 | 87 | 0.14 | 0.157 | 61 | 0.13 | 0.164 | 26 |
| | | Total | 0.08 | 0.137 | 202 | 0.07 | 0.134 | 147 | 0.08 | 0.144 | 55 |
| | DUAL | With G-C | 0.38 | 0.488 | 115 | 0.41 | 0.494 | 86 | 0.31 | 0.471 | 29 |
| | | Healthy | 0.37 | 0.485 | 87 | 0.33 | 0.473 | 61 | 0.46 | 0.508 | 26 |
| | | Total | 0.38 | 0.486 | 202 | 0.37 | 0.486 | 147 | 0.38 | 0.49 | 55 |
| | PLE | With G-C | 32.05 | 35.821 | 115 | 33.25 | 36.053 | 86 | 28.48 | 35.509 | 29 |
| | | Healthy | 5.93 | 13.133 | 87 | 5.63 | 13.323 | 61 | 6.64 | 12.905 | 26 |
| | | Total | 20.8 | 31.138 | 202 | 21.79 | 31.876 | 147 | 18.16 | 29.189 | 55 |
| | FAMILY | With G-C | 0.3 | 0.462 | 115 | 0.28 | 0.451 | 86 | 0.38 | 0.494 | 29 |
| | | Healthy | 0.55 | 0.5 | 87 | 0.56 | 0.501 | 61 | 0.54 | 0.508 | 26 |
| | | Total | 0.41 | 0.493 | 202 | 0.39 | 0.49 | 147 | 0.45 | 0.503 | 55 |
| | SEATCON | With G-C | 46.55 | 32.856 | 115 | 50.07 | 31.904 | 86 | 36.14 | 33.983 | 29 |
| | | Healthy | 24.27 | 22.629 | 87 | 23.94 | 23.609 | 61 | 25.05 | 20.566 | 26 |
| | | Total | 36.96 | 30.883 | 202 | 39.22 | 31.441 | 147 | 30.89 | 28.737 | 55 |
| | CASHCON | With G-C | 85.21 | 28.15 | 115 | 87.4 | 26.462 | 86 | 78.71 | 32.284 | 29 |
| | | Healthy | 85.48 | 20.93 | 87 | 86.4 | 18.692 | 61 | 83.33 | 25.72 | 26 |
| | | Total | 85.33 | 25.237 | 202 | 86.98 | 23.484 | 147 | 80.9 | 29.191 | 55 |
| | BIG4 | With G-C | 0.53 | 0.501 | 115 | 0.51 | 0.503 | 86 | 0.59 | 0.501 | 29 |
| | | Healthy | 0.76 | 0.43 | 87 | 0.7 | 0.46 | 61 | 0.88 | 0.326 | 26 |
| | | Total | 0.63 | 0.484 | 202 | 0.59 | 0.493 | 147 | 0.73 | 0.449 | 55 |

**Table 3.** Contd.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Financial performance | EPS | With G-C | -2.89 | 4.592 | 115 | -3.02 | 4.508 | 86 | -2.54 | 4.897 | 29 |
| | | Healthy | 1.13 | 2.343 | 87 | 1.24 | 2.131 | 61 | 0.87 | 2.808 | 26 |
| | | Total | -1.16 | 4.277 | 202 | -1.25 | 4.257 | 147 | -0.93 | 4.362 | 55 |
| | DEBTRATIO | With G-C | 125.4252 | 110.96803 | 115 | 127.6752 | 97.10532 | 86 | 118.7528 | 146.45281 | 29 |
| | | Healthy | 47.2339 | 19.49024 | 87 | 46.4415 | 18.83167 | 61 | 49.0931 | 21.22514 | 26 |
| | | Total | 91.7488 | 93.02203 | 202 | 93.9660 | 85.13796 | 147 | 85.8227 | 112.07980 | 55 |
| | ROA | With G-C | -14.0635 | 22.96101 | 115 | -13.0640 | 19.31170 | 86 | -17.0276 | 31.65717 | 29 |
| | | Healthy | 3.0441 | 10.80343 | 87 | 4.0651 | 6.17324 | 61 | .6488 | 17.36447 | 26 |
| | | Total | -6.6953 | 20.51998 | 202 | -5.9560 | 17.44999 | 147 | -8.6715 | 27.17657 | 55 |

**Table 4.** Parameter estimates for three multivariate analysis models for firms with different industry affiliation (a).

| Dependent variable | Complete model (manufacturing, service) | | | | | | Manufacturing industry only | | | | | | Service industry only | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B | Std. error | T | Sig. | 95% C.I. L.B. | 95% C.I. U.B. | B | Std. error | t | Sig. | 95% C.I. L.B. | 95% C.I. U.B. | B | Std. error | t | Sig. | 95% C.I. L.B. | 95% C.I. U.B. |
| AFFILIATION | 0.047 | 0.063 | 0.735 | 0.463 | -0.078 | 0.172 | | | | | | | | | | | | |
| BDSIZE | -2.031 | 0.315 | -6.452 | 0.000 | -2.652 | -1.41 | -2.358 | 0.382 | -6.178 | 0.000 | -3.112 | -1.604 | -1.174 | 0.543 | -2.163 | 0.035 | -2.262 | -0.085 |
| INDEPENDENT | -0.11 | 0.018 | -6.195 | 0.000 | -0.145 | -0.075 | -0.119 | 0.02 | -5.904 | 0.000 | -0.159 | -0.079 | -0.086 | 0.037 | -2.307 | 0.025 | -0.161 | -0.011 |
| DUAL | 0.015 | 0.069 | 0.214 | 0.831 | -0.122 | 0.151 | 0.079 | 0.081 | 0.973 | 0.332 | -0.082 | 0.240 | -0.151 | 0.132 | -1.145 | 0.257 | -0.416 | 0.114 |
| PLE | 26.111 | 4.033 | 6.474 | 0.000 | 18.159 | 34.064 | 27.613 | 4.838 | 5.707 | 0.000 | 18.051 | 37.176 | 21.843 | 7.37 | 2.964 | 0.005 | 7.060 | 36.625 |
| FAMILY | -0.247 | 0.068 | -3.636 | 0.000 | -0.382 | -0.113 | -0.278 | 0.079 | -3.52 | 0.001 | -0.435 | -0.122 | -0.159 | 0.135 | -1.177 | 0.245 | -0.430 | 0.112 |
| SEATCON | 22.284 | 4.107 | 5.426 | 0.000 | 14.185 | 30.383 | 26.128 | 4.815 | 5.426 | 0.000 | 16.611 | 35.644 | 11.091 | 7.685 | 1.443 | 0.155 | -4.323 | 26.505 |
| CASHCON | -0.275 | 3.595 | -0.077 | 0.939 | -7.364 | 6.813 | 0.997 | 3.944 | 0.253 | 0.801 | -6.797 | 8.792 | -4.618 | 7.933 | -0.582 | 0.563 | -20.529 | 11.293 |
| BIG4 | -0.228 | 0.067 | -3.402 | 0.001 | -0.36 | -0.096 | -0.193 | 0.081 | -2.378 | 0.019 | -0.354 | -0.033 | -0.298 | 0.115 | -2.584 | 0.013 | -0.530 | -0.067 |
| EPS | -4.022 | 0.539 | -7.464 | 0.000 | -5.084 | -2.959 | -4.253 | 0.622 | -6.842 | 0.000 | -5.482 | -3.025 | -3.404 | 1.093 | -3.113 | 0.003 | -5.597 | -1.211 |
| DEBTRATIO | 78.191 | 12.042 | 6.493 | 0.000 | 54.446 | 101.937 | 81.234 | 12.610 | 6.442 | 0.000 | 56.311 | 106.156 | 69.660 | 29.018 | 2.401 | 0.020 | 11.457 | 127.863 |
| ROA | -17.108 | 2.661 | -6.429 | 0.000 | -22.355 | -11.861 | -17.129 | 2.563 | -6.684 | 0.000 | -22.194 | -12.064 | -17.676 | 7.000 | -2.525 | 0.015 | -31.716 | -3.637 |

(a): Confidence level = 0.05.

training data set based on the goodness-of-splitting criteria. This splitting step will exhaustively consume the computation resource until finding the “best” splitting point for all dependent variables which can reduce the “impurity” of the overall classification tree.

In this research, 80% of sampling firms are served as the training dataset and the remaining 20% of firms are treated as test data set. In short,

**Table 5.** Priorities of the significant variables entering into the CART decision tree model.

| MANOVA | Complete model (manufacturing, service) | | | Manufacturing industry only | | | | Service industry only | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Models priority** | **Dependent variables** | **F** | **Sig.** | **Priority** | **Dependent variables** | **F** | **Sig.** | **Priority** | **Dependent variables** | **F** | **Sig.** |
| 1 | BDSIZE | 41.628 | 0.000 | 1 | BDSIZE | 38.172 | 0.000 | 1 | PLE | 8.783 | 0.005 |
| 2 | INDEPENDENT | 38.375 | 0.000 | 2 | INDEPENDENT | 34.855 | 0.000 | 2 | BIG4 | 6.678 | 0.013 |
| 3 | PLE | 41.919 | 0.000 | 3 | PLE | 32.572 | 0.000 | 3 | DEBTRATIO | 6.377 | 0.015 |
| 4 | FAMILY | 13.217 | 0.000 | 4 | SEATCON | 29.446 | 0.000 | 4 | EPS | 5.763 | 0.020 |
| 5 | SEATCON | 29.437 | 0.000 | 5 | EPS | 46.819 | 0.000 | 5 | ROA | 5.763 | 0.020 |
| 6 | EPS | 42.162 | 0.000 | 6 | DEBTRATIO | 41.502 | 0.000 | 6 | INDEPENDENT | 5.321 | 0.025 |
| 7 | DEBTRATIO | 41.335 | 0.000 | 7 | ROA | 44.672 | 0.000 | 7 | BDSIZE | 4.677 | 0.035 |
| 8 | ROA | 78.235 | 0.000 | 8 | FAMILY | 12.389 | 0.001 | n/a | SEATCON | 2.083 | 0.155 |
| 9 | BIG4 | 11.571 | 0.001 | 9 | BIG4 | 5.657 | 0.019 | n/a | FAMILY | 1.385 | 0.245 |
| n/a | AFFILIATION | 0.541 | 0.463 | n/a | DUAL | 0.947 | 0.332 | n/a | DUAL | 1.311 | 0.257 |
| n/a | DUAL | 0.046 | 0.831 | n/a | CASHCON | 0.064 | 0.801 | n/a | CASHCON | 0.339 | 0.563 |
| n/a | CASHCON | 0.006 | 0.939 | | | | | | | | |

*Confidence level = 0.05.

92 firms with G-C and 70 matching healthy firms are randomly extracted from the illustrative database and those firms can be further categorized as 115 manufacturing industry firms and 47 service industry firms.

The CART model is created by Clementine 11.1. The major algorithmic settings include: the maximum surrogate number is 10, minimum change in impurity is 0.0001, impurity measure for categorical targets is based on GINI method, the minimum records in the parent branch is 2%, and the minimum records in the child branch is 1%.

The construction process of the CART decision tree started with the factor which has the highest significant effect to the firms with G-C risk (Table 5). The decision tree initiates the generation of branches for the manufacturing and service industries separately, and then expands the decision tree.

For the manufacturing industry firms, the priorities of the considerations are as the following: BDSIZE (the size of directors on the board) → INDEPENDENT (Percentage of independent directors in BOD) → PLE (The ratio of the total pledged shares to the total on-hand shares of the BOD and supervisors) → SEATCON (ratio of the right of seating over the right of control) → EPS (earnings per share) → DEBTRATIO (ratio of total liabilities to total assets) → ROA (return on total assets) →FAMILY (the final controller group (that is, a family group) at the end of year hold shares in the BOD exceed 50% of the total shares in BOD) →BIG4 (the external auditing agency belongs to Big 4 CPA firms). Similarly, the sequence to introduce the significant factors into the service industry firms decision branch is: PLE (the ratio of the total pledged shares to the total on-hand shares of the BOD and supervisors) → BIG4 (the external auditing agency belongs to Big 4 CPA firms) → DEBTRATIO (ratio of total liabilities to total assets) → EPS (earnings per share) →ROA (return on total assets) →INDEPENDENT (percentage of independent directors in BOD) → BDSIZE (the size of directors on the board).

In order to save the bandwidth of this paper, the graphical decision tree is converted as the decision rules set format. This resultant decision rules set (please refer to Appendix) includes 21 rules to detect firms with G-C risk status and 15 rules for the healthy status, respectively.

For the illustration, the financial analyst or investors will pay more attention to avoid a resultant manufacturing firm with G-C risk if it complies with the conditions indicated in G-C Rule1: its BDSIZE is less or equal than 7.5, PLE is larger than 24.725, and ROA is less than -5.225. On the other hand, favorable investment decision may

**Table 6**. Classification performance in estimation risk.

| | Predicted | | |
|---|---|---|---|
| **Actual** | **0 (Healthy)** | **1 (With G-C)** | **Total** |
| **Risk estimation from the training dataset** | | | |
| 0 (Healthy) | 91 | 1 | 92 |
| 1 (With G-C) | 1 | 69 | 70 |
| Total | 92 | 70 | 162 |
| Risk estimated =0.012 | | Standard error =0.009 | |
| **Successful estimation performance of the testing dataset** | | | |
| 0 (Healthy) | 14 | 3 | 17 |
| 1 (With G-C) | 2 | 21 | 23 |
| Total | 16 | 24 | 40 |
| Successful Classification Ratio =0.875 | | | |

berendered to a targeting healthy manufacturing firm if it matches conditions in Healthy Rule 1: its BDSIZE is larger than 7.5, PLE is less or equal than 24.725, ROA is larger than -5.225, EPS is less or equal than 0.24 and is a family-owned firm (FAMILY = 1).

From the training dataset, the CART decision rules demonstrate satisfactory results in the estimation risk for firms with G-C. 160 firms out of the 162 training firms are successfully estimated in the dataset which is equivalent to 0.012 estimation risk or 98.8% confidence level.

From the testing dataset, the total successful classification ratio is 87.50% or 38 out of the total testing 40 records are successfully classified (Table 6).

## Conclusions

To have both accurate and efficient procedure to detect a firm with potentially going-concern problem is crucial for the financial analyst and investors. This warning signal is even more critical during the financial tsunami. Based on the general practice experiences and literature review, investigating firms with going-concern risk should be varied according to different industry affiliation, effectiveness of the corporate governance function, and certainly, the performance of the financial operation aspects.

In this study, two hundred and two firms, containing firms with going-concern risk and the corresponding healthy firms with similar business profiles between 2000 and 2008 are extracted from Taiwan's TSE and GTSM-OTC databases.

An enhanced two-step analytical approach is developed to detect with the G-C behaviors of a firm: 1) the multivariate analysis (MA) procedure is applied to identify the influential factors for the firms with going-concern risk, and 2) in order to enhance the decision making efficiency in practice, only those significant factors identified from the first step are incorporated into the classification and regression tree technique (CART) model in a prioritized fashion to detect the status of the target firms.

From the MA model, consistent with prior research results, the important findings are that the firms with going-concern risk tend to have less size of BOD, smaller percentage of independent directors in BOD, higher ratio of the shares pledged, less family-type, larger cash flow deviation, less audited by Big 4 CPA firms, poorer earnings per share, higher debt ratio, and less return on total assets. The duality of the chairman and the CEO and the ratio of the right for cash flow over the right of control do not play significant role. From the CART model, the decision tree is expanded based on the most-significant-factor-first rule. The resultant decision rules set demonstrates satisfactory detection capability with 98.8% confidence level, 87.5% accuracy rate, and 52% of decision nodes contributing 100% response rate. The major accomplishments of this study can be concluded in two aspects.

Firstly, from the financial accounting and corporate governance professional practice point of view, the practical finding of the influential factors provides comprehensive understandings of the behaviors of the firms with C-G risks in Taiwan's stock market.

Secondly, weighing from the decision tree modeling, the innovative theoretical development successfully demonstrates itself as an effective detective and analytical tool.

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## APPENDIX

Decision rules converted from the CART decision tree.

**Rules for G-C - contains 21 rule(s)**

Rule 1
if AFFILIATION in [ "Manufacturing" ] and BDSIZE <= 7.500 and PLE > 24.725 and ROA <= -5.225 then With G-C

Rule 2
if AFFILIATION in [ "Manufacturing" ] and BDSIZE <= 7.500 and PLE > 24.725 and ROA > -5.225 and EPS <= 0.240 and FAMILY in [ 0.000 ] then With G-C

Rule 3
if AFFILIATION in [ "Manufacturing" ] and BDSIZE <= 7.500 and PLE > 24.725 and ROA > -5.225 and EPS > 0.240 and FAMILY in [ 0.000 ] and BDSIZE <= 3 then With G-C

Rule 4
if AFFILIATION in [ "Manufacturing" ] and BDSIZE <= 7.500 and PLE > 24.725 and ROA <= -3.140 then With G-C

Rule 5
if AFFILIATION in [ "Manufacturing" ] and BDSIZE <= 7.500 and PLE > 24.725 and ROA > -3.140 and EPS > 0.680 then With G-C

Rule 6
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE <= 44.660 and ROA <= -15.260 and EPS <= -3.230 then With G-C

Rule 7
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE <= 44.660 and ROA <= -15.260 and EPS > -3.230 and FAMILY in [ 0.000 ] then With G-C

Rule 8
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE <= 44.660 and ROA <= -15.260 and EPS > -3.230 and FAMILY in [ 1.000 ] and BDSIZE <= 11.500 then With G-C

Rule 9
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE <= 44.660 and ROA > -15.260 and EPS <= 1.045 and FAMILY in [ 0.000 ] and INDEPENDENT > 0.183 and DUAL in [ 0.000 ] then With G-C

Rule 10
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE <= 44.660 and ROA > -15.260 and EPS <= 1.045 and FAMILY in [ 1.000 ] and INDEPENDENT <= 0.354 and CASHCON <= 47.235 then With G-C

Rule 11
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE <= 44.660 and ROA > -15.260 and EPS <= 1.045 and FAMILY in [ 1.000 ] and INDEPENDENT <= 0.354 and CASHCON > 47.235 and SEATCON <= -22.505 then With G-C

Rule 12
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE <= 44.660 and ROA > -15.260 and EPS <= 1.045 and FAMILY in [ 1.000 ] and INDEPENDENT > 0.354 and DUAL in [ 0.000 ] then With G-C

Rule 13
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE > 44.660 and ROA <= 4.870 then With G-C

Rule 14
if AFFILIATION in [ "Service" ] and PLE <= 29.415 and DUAL in [ 0.000 ] and BDSIZE <= 8.500 and INDEPENDENT <= 0.143 and EPS <= -0.920 then With G-C

Rule 15
if AFFILIATION in [ "Service" ] and PLE <= 29.415 and DUAL in [ 0.000 ] and BDSIZE <= 8.500 and INDEPENDENT <= 0.143 and EPS > -0.920 and CASHCON <= 56.560 then With G-C

Rule 16
if AFFILIATION in [ "Service" ] and PLE <= 29.415 and DUAL in [ 0.000 ] and BDSIZE <= 8.500 and INDEPENDENT <= 0.143 and EPS > -0.920 and CASHCON > 56.560 and BDSIZE > 7.500 then With G-C

Rule 17
if AFFILIATION in [ "Service" ] and PLE <= 29.415 and DUAL in [ 0.000 ] and BDSIZE <= 8.500 and INDEPENDENT > 0.143 then With G-C

Rule 18
if AFFILIATION in [ "Service" ] and PLE <= 29.415 and DUAL in [ 0.000 ] and BDSIZE > 8.500 and INDEPENDENT <= 0.111 and EPS <= 0.210 then With G-C

Rule 19
if AFFILIATION in [ "Service" ] and PLE <= 29.415 and DUAL in [ 1.000 ] and BDSIZE <= 5 then With G-C

Rule 20
if AFFILIATION in [ "Service" ] and PLE <= 29.415 and DUAL in [ 1.000 ] and BDSIZE > 5 and CASHCON > 99.975 then With G-C
Rule 21 for With G-C
if AFFILIATION in [ "Service" ] and PLE > 29.415 then With G-C

**Rules for healthy firms- contains 15 rule(s)**

Rule 1
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE <= 24.725 and ROA > -5.225 and EPS <= 0.240 and FAMILY in [ 1.000 ] then Healthy

Rule 2
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE <= 24.725 and ROA > -5.225 and EPS > 0.240 and FAMILY in [ 0.000 ] and BDSIZE > 3 then Healthy

Rule 3
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE <= 24.725 and ROA > -5.225 and EPS > 0.240 and FAMILY in [ 1.000 ] then Healthy

Rule 4
if AFFILIATION in [ "Manufacturing" ] and BDSIZE >7.500 and PLE > 24.725 and ROA > -3.140 and EPS <= 0.680 then Healthy

Rule 5
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE <= 44.660 and ROA <= -15.260 and EPS > -3.230 and FAMILY in [ 1.000 ] and BDSIZE > 11.500 then Healthy

Rule 6
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE <= 44.660 and ROA > -15.260 and EPS <= 1.045 and FAMILY in [ 0.000 ] and INDEPENDENT <= 0.183 then Healthy

Rule 7
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE <= 44.660 and ROA > -15.260 and EPS <= 1.045 and FAMILY in [ 0.000 ] and INDEPENDENT > 0.183 and DUAL in [ 1.000 ] then Healthy

Rule 8
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE <= 44.660 and ROA > -15.260 and EPS <= 1.045 and FAMILY in [ 1.000 ] and INDEPENDENT <= 0.354 and CASHCON > 47.235 and SEATCON > -22.505 then Healthy

Rule 9
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE <= 44.660 and ROA > -15.260 and EPS <= 1.045 and FAMILY in [ 1.000 ] and INDEPENDENT > 0.354 and DUAL in [ 1.000 ] then Healthy

Rule 10
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE <= 44.660 and ROA > -15.260 and EPS > 1.045 then Healthy

Rule 11
if AFFILIATION in [ "Manufacturing" ] and BDSIZE > 7.500 and PLE > 44.660 and ROA > 4.870 then Healthy

Rule 12
if AFFILIATION in [ "Service" ] and PLE <= 29.415 and DUAL in [ 0.000 ] and BDSIZE <= 8.500 and INDEPENDENT <= 0.143 and EPS > -0.920 and CASHCON > 56.560 and BDSIZE <= 7.500 then Healthy

Rule 13
if AFFILIATION in [ "Service" ] and PLE <= 29.415 and DUAL in [ 0.000 ] and BDSIZE > 8.500 and INDEPENDENT <= 0.111 and EPS > 0.210 then Healthy

Rule 14
if AFFILIATION in [ "Service" ] and PLE <= 29.415 and DUAL in [ 0.000 ] and BDSIZE > 8.500 and INDEPENDENT > 0.111 then Healthy

Rule 15
if AFFILIATION in [ "Service" ] and PLE <= 29.415 and DUAL in [ 1.000 ] and BDSIZE > 5 and CASHCON <= 99.975 then Healthy