The Application of EBO Model to Forecast Financial Distressed Companies

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Abstract

Financial distress has been an important topic in corporate governance. This study applies EBO (Edwards-Bell-Ohlson) model to forecast financial distress. EBO model itself and two decision tree approaches based on the variables in the EBO models are used. 36 sample listed companies in TSEC (Taiwan Stock Exchange Corp.) are used as the data. These data are further divided into training and forecasting samples. The training sample is used to induct the rules for forecasting, while the forecasting sample is used to test against the rules. Empirical analyses are provided to compare the performance between the EBO model and the two decision tree approaches.

Keywords: financial distress, full-delivery, Edwards-Bell-Ohlson (EBO) model, decision trees, firm intrinsic values

1. Introduction

The topic of financial distress is gaining more and more attention. There have been many studies adopted financial ratios for forecasting. Recently, Edwards-Bell-Ohlson (EBO) model has been so popular in evaluating the values of companies. This study, hence, applies EBO model to forecast financial distress. The EBO model itself is applied to forecast. In addition, based on the variables in the EBO model, two decision tree approaches (C 5.0 and CART) are used. The study period is between year 2000 and 2004. There are 36 listed companies in TSEC (Taiwan Stock Exchange Corp.) used as the data, including 12 financial distressed companies matched with 24 healthy counterparts. These data are further divided into training and forecasting samples. The training sample is used to induct the rules for forecasting, while the forecasting sample is used to test against the rules. The empirical results show that CART performs the forecasting best among the three, up to 83.33% accuracy.

2. Literature Review

There have been many relevant studies to forecast financial distressed companies. Efforts to differentiate between distressed and healthy companies began with Beaver's (1966) early use of financial ratios. That study was followed by Altman's (1968) Z-score, which was based on multiple discriminant analysis.

In this study, we apply a derived EBO model (Lee, 1996) and two decision tree methodologies for forecasting, including C5.0 and CART. Breiman et al. (1984) proposed a Classification and Regression Tree (CART) theory. CART was designed to handle classification or prediction problem. C4.5 (Kauffman, 1993) was proposed to improve ID3. And C5.0 is a revised edition of C4.5. Though CART is similar to C4.5, there are some major differences. For example, CART always performs binary splits on the data regardless whether the variables are categorical or numeric. In addition, CART invokes test data to help prune and therefore generalize a binary tree, whereas C4.5 uses only training data to create a final tree structure.

3. Data

We collect the data from TEJ (Taiwan Economics Journal) database. The listed companies that encountered financial distress in Taiwan are chosen. Healthy counterparts are also selected. The study period is between year 2000 and 2004. The reason is to avoid the period of the Asia financial crisis, where many companies went bankrupted because of the financial crisis. Meanwhile, we refer the financial distressed companies to as those which were declared full-delivery. There were 12 distressed companies.

We adopt the principle in (Beaver, 1966) to collect distressed and healthy companies by the proportion of 1: 2. In all, there were 36 companies. Hence, we use 8 distressed companies and 16 matching healthy ones for estimation.

4. Methodology

4.1 EBO Model

A number of prior studies showed that, as long as the forecasts of earnings, book values and dividends follow clean surplus accounting, the dividend discount valuation model is algebraically equivalent to a residual income valuation model (Preinreich, 1938; Edwards and Bell, 1961; Peasnell, 1982; Ohlson, 1995). The EBO model is an infinite-horizon model, and its implementation requires the term to become fixed from some period *t* moving forwards. Professor Victor Bernard, when he was the America Accounting Association's director of research, ever predicted the EBO model would have sweeping effects on future research (Lee, 1996).

Because of the EBO model is based on concept of residual income (RI). So the concept of residual income valuation is as follow:

$$RI = earnings_t - (r \times capital_{t\text{-}1}) \quad (1)$$

where $capital_{t\text{-}1}$ is total asset and r is a firm's cost of capital (calculated by CAPM[1]). Finally, $earnings_t$ is the intrinsic income before interest of a firm. So Equation 1 shows that it will have residual income when the intrinsic income is in the excess of the return of $capital_{t\text{-}1}$.

The following are equations of the firm intrinsic values:

$$firm\ value = capital_t + present\ value\ of\ all\ future\ RI_S \quad (2)$$

$$= B_t + \sum_{i=1}^{\infty} \frac{E_t[(ROE_{t+i} - r_e) \times B_{t+i-1}]}{(1+r_e)^i} \quad (3)$$

$$= B_t + \sum_{i=1}^{T} \frac{(ROE_{t+i} - r_e)}{(1+r_e)^i} \times B_{t+i-1} + \frac{(ROE_{t+T+1} - r_e)}{r_e(1+r_e)^T} \times B_{t+T} \quad (4)$$

Equation 2 show that the firm intrinsic values are the total asset firm invest plus *present value of all future* RI_S. However, EBO model is based on shareholder's equity, so we get Equation 3 rewritten from Equation 2. But, Equation 3 expresses the firm value in terms of an infinite series. For practical purposes, the explicit forecast period is shorter, so we rewrite Equation 3 to Equation 4. Finally, Lee (1996) used spreadsheet to implement EBO valuation model according to Equation 4.

The EBO model of Lee (1996) requires five inputs: book value (B_t), FY1 and FY2 earning forecasts[2], long-term consensus earning growth rate (Long-term EPS_{growth} in the future), cost of capital (r_e), and dividend payout ratio. And the dividend policy of a company corresponds to the clean surplus relation, CSR[3].

These inputs are used to compute a firm's expected abnormal earnings, which are the earnings in the excess of cost of capital in the future. The expected abnormal earnings are then discounted at the firm's cost of capital, which combined with the firm's book value, determines its intrinsic value. In this study, we adopt a derived version of the EBO model (Lee, 1996) to calculate firms' intrinsic values.

Thus, we adjust some parameters in the EBO model because some of them are not suitable in the case in Taiwan. The adjusted parameters for EBO model (Lee, 1996) are listed as follows.

(x_1) - Long-term EPS_{growth} in the future: We adopt the average of growing rate of real EPS afterwards to substitute the long-term EPS_{growth} in the future, and it is called "perfect forecast".

(x_2) - Forecast EPS: The forecasting period in the US is of two years but only one year in Taiwan. Hence, we just use forecast EPS at the end of the first year (Forecast EPS in FY1).

(x_3) - Book value per share: We adopt the book value per share in the first year.

(x_4) - Cost of equity capital, r_e : This variable is similar to the discount rate, essential rate-of-return. But unfortunately, the rate of returns in Taiwan's stock market is negative in some years. We cannot apply it to the CAPM. Hence, we use the stable discount rate instead. We calculate the average rate-of-return in the electronic sector from 1981 to 2004, which is 10.74%.

(x_5) - Dividend payout ratio: We adopt the dividend payout ratio of the first year.

4.2 Decision Trees

Because r_e (x_4) is fixed in this study and most of sample companies didn't pay dividends (x_5=0). So we can ignore these two parameters.

Then we use the adjusted parameters ($x_1 \sim x_3$) as the inputs to the decision trees. Two decision tree models - C5.0 and CART are used to forecast whether a company is distressed. The structure of these two models is depicted as in Figure 1.

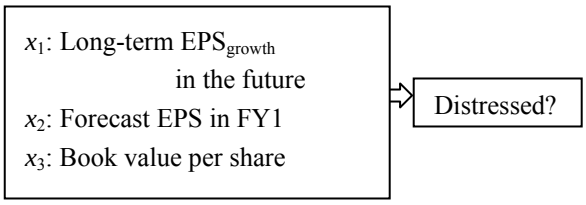

Figure1. Study Structure

5. Empirical Results

We separate the data into 24 for training and 12 forecasting, both with healthy and distressed companies.

5.1 Training

First, the judgment of whether a firm is in financial distress by EBO model was to examine whether the value of the stock was lower than the par value: NT$10. Meanwhile, we apply the two decision trees based on EBO model to predict distressed companies.

5.2 Forecast by EBO Model

First, we calculate the firm intrinsic values by EBO model balance (Lee, 1996). The judgment is to examine whether the value of the stock is lower than the par value: NT$10. The forecast results from the EBO model is listed in Table 1. Figures 2 to 3 depict part of sample companies forecast by EBO model. In these figures, the codes in the parentheses represent different listed companies. The #'s are to block some of the digits.

Table 1. Forecasts by EBO

	Forecast as Healthy	Forecast as Distressed	Total
Healthy	6	2	8
Distressed	1	3	4

Type error =2/8=25%
Type error =1/4=25%
Total rate of accuracy =75%

5.3 Forecast by Decision Trees

(A) C5.0

Table 2. Forecasts by C5.0

	Forecast as Healthy	Forecast as Distressed	Total
Healthy	7	1	8
Distressed	3	1	4

Type error =1/8=12.5%
Type error =3/4=75%
Total rate of accuracy =66.67%

(B) CART

Table 3. Forecasts by CART

	Forecast as Healthy	Forecast as Distressed	Total
Healthy	8	0	8
Distressed	2	2	4

Type error = 0/8=0%
Type error = 2/4=50%
Total rate of accuracy=83.33%

5.4 Comparisons

We compare the forecasting results from the EBO model with those from the C5.0 and CART. Regarding the total rate of accuracy, CART performs the best. So we discuss the results from CART further.

There are seven rules, as follows, generated by CART that can classify the 24 training samples correctly.

Rule 1 IF *Long-term* EPS_{growth} *in the future* -0.015
AND *EPS Forecast in FY1* -2.48
THEN *Health =Yes* (12, 1.0)

Rule 2 IF *Long-term* EPS_{growth} *in the future* -0.015
AND *EPS Forecast in FY1* -2.48
THEN *Distress=Yes* (1, 1.0)

Rule 3 IF -0.47 *Long-term* EPS_{growth} *in the future* -0.015
AND *Book Value Per Share* 16.86
THEN *Distress=Yes* (3, 1.0)

Rule 4 IF *Long-term* EPS_{growth} *in the future* -0.47
AND *Book Value Per Share* 16.86
THEN *Distress=Yes* (1, 1.0)

Rule 5 IF *Long-term* EPS_{growth} *in the future* -0.015
AND *Book Value Per Share* 16.86
AND *EPS Forecast in FY1* -0.175
THEN *Distress=Yes* (5, 1.0)

Rule 6 IF *Long-term* EPS_{growth} *in the future* -0.015
AND *Book Value Per Share* 16.86
AND -0.845 *EPS Forecast in FY1* -0.175
THEN *Healthy=Yes* (1, 1.0)

Rule 7 IF *Long-term* EPS_{growth} *in the future* -0.015
AND *Book Value Per Share* 16.86
AND *EPS Forecast in FY1* -0.845
THEN *Distress=Yes* (1, 1.0)

However, when we use these rules to test the 12 testing samples, the total rate of accuracy is 83.33%. The decision tree created by CART is depicted in Figure 4. And the rules are listed above. In Figure 4, we know that the Long-term EPS_{growth} in the future(x_1) is the most important parameter in CART, which matches the EBO model. On the other hand, the parameter is also the parameter that is most difficult to measure. Forecast EPS in FY1 and Book value per share are the next important parameters.

6. Conclusion

To forecast financial distressed companies becomes a popular topic in corporate governance. This study applied the derived EBO model for forecasting. The variables in the model were also used in the decision trees. The forecasting results show that the variables in the derived EBO model can be used to forecast the financial distressed companies in Taiwan

successfully (all total rate of accuracy in these three models are better than 67%). This shows that EBO model can be applied for evaluation as well as forecasting financial distress.

Meanwhile, Type errors among these three models are higher than their corresponding Type errors. This conclusion tells us that we will make better decision in choosing stock.

Finally, among EBO model, C5.0, and CART, CART provided the best forecasting results (with an accuracy rate of 83.33%).

Note

[1]. $\overline{R}_i = R_F + \beta_i \times (\overline{R}_M - R_F)$

Expected return on a security = Risk-free rate+ Beta of the security×Market risk premium

[2]. $EPS_t = EPS_{t-1}(1 + EPS_{growth})$

This Equation means that the *EPS* of year *t* is equal to the *EPS* in year *t*-1 multiplying (1+ EPS_{growth})

[3]. $D_t = B_{t-1} + N_t - B_t$

where D_t is dividend at t year, B_{t-1} is book value at year *t*-1, N_t is net income at year *t*, B_t is book value at year *t*.

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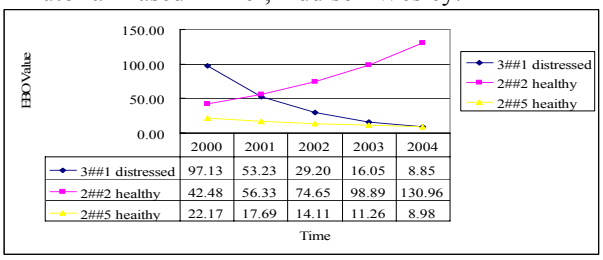
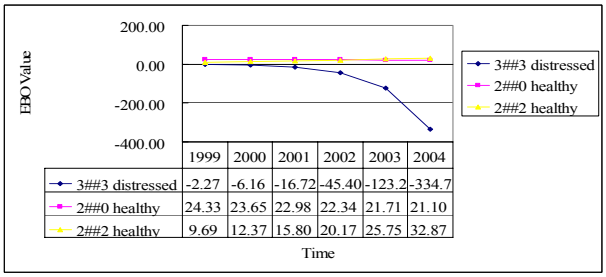


	2000	2001	2002	2003	2004
3##1 distressed	97.13	53.23	29.20	16.05	8.85
2##2 healthy	42.48	56.33	74.65	98.89	130.96
2##5 healthy	22.17	17.69	14.11	11.26	8.98

Figure 2. (3##1) Financial Distressed in 2004



	1999	2000	2001	2002	2003	2004
3##3 distressed	-2.27	-6.16	-16.72	-45.40	-123.2	-334.7
2##0 healthy	24.33	23.65	22.98	22.34	21.71	21.10
2##2 healthy	9.69	12.37	15.80	20.17	25.75	32.87

Figure 3. (3##3) Financial Distressed in 2003

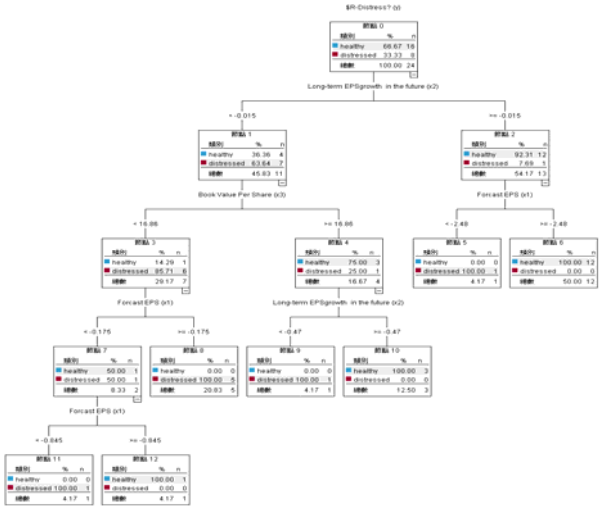


Figure 4. Decision Tree from CART