Generalized Entropy Increase Verification and Corporate Earnings Management Based on Decision Tree Model

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ABSTRACT

With the increasing requirements of the financial market, the approval standards for listing on the stock market have become higher, leading to many private enterprises being excluded. As a result, a method called "backdoor listing" has become popular in the financial market for entry. To demonstrate their strength, many companies choose to sign performance commitments before listing, with all employees committing to performance, and then report the final performance commitment to relevant authorities for approval. However, this approach has exposed several issues, primarily arising from the misalignment between performance commitments and final corporate earnings. Therefore, it is essential to evaluate the performance commitments made by employees scientifically, avoid corporate earnings management, and thereby mitigate the risk of "performance plunge" and "performance cliff" after listing. This study collects large data using data mining and applies cluster analysis to divide performance commitments. Finally, the relationship between employee performance commitments and corporate earnings management impact is identified based on the decision tree model algorithm. The results indicate that unreasonable performance commitments are one of the main reasons for improper corporate earnings management. Using the decision tree model algorithm can make correct decisions to reduce the risks caused by employee performance commitments. The study takes the employee performance commitments and corporate earnings management under the state of mergers and acquisitions as an example to elaborate on this conclusion using the algorithm.

1. Introduction

For enterprises, employee commitments help plan specific developments for the next quarter and budget for

before they are implemented. This enables preliminary calculations of annual corporate earnings, thus formulating better management plans and making appropriate management decisions. Therefore, employee performance commitments have always been an important part of enterprise development. With the stock market's rise, studying employee performance commitment motives has been a hot topic in academic research. Generally, we believe that employee performance commitments have the following main impacts: On the one hand, there is a specific positive correlation between employee performance commitments and the estimated corporate annual performance. The higher the employee performance commitment, the more it reflects the corporate annual goals, conveying an optimistic signal to the market and indicating the company's confidence in its future development. On the other hand, employee performance commitments can alleviate the problem of information asymmetry between the two parties. Typically, the less the market knows about a company, the greater the possibility of signing an employee performance commitment agreement between the two parties [1]. In 2019, Professor Shen Huayu's paper "Does the Target Information Asymmetry Affect Performance Guarantee in mergers and acquisitions in China?" studied non-listed companies using game theory and found that the degree of information asymmetry is significantly proportional to the likelihood of signing an employee performance commitment agreement, directly proving the above conclusion [2]. Finally, employee performance commitments can also protect the rights of relevant stakeholders. Both the market and the enterprise will not enter into cooperation unprepared, and even before cooperation, they will assume the worst-case scenario and develop a final contingency plan. In this case, the employee's performance commitment is one of the bases for formulating the contingency plan, and the market can require the addition of specific terms to the employee's performance commitment agreement to protect the interests of both parties effectively. At the same time, it can constrain the rights and obligations of both parties, ensuring unity of interests and using incentives and constraints together to ensure a win-win cooperation.

However, despite these benefits, due to market and human factors, in some cases, employee performance commitments have not positively impacted corporate earnings management as expected. Instead, in some extreme cases, due to excessively high employee performance commitments, the company's value is artificially inflated by the market, and the company can only temporarily cover it up through earnings management, resulting in the "hollowing out" of employee performance commitments, which can cause significant harm. Even if the company successfully completes the cooperation with the market based on employee performance commitments, after the commitment period, many companies experience a sharp decline in performance [3]. Therefore, the above research proves that unreasonable employee performance commitments are the leading cause of improper corporate earnings management. Consequently, the research's focus has shifted to setting reasonable employee performance commitments to avoid corporate earnings management [4].

2. Employee Performance Commitment and Corporate Earnings Management

As of March 2023, there are 3,338 papers related to "employee performance commitment" on the China National Knowledge Infrastructure (CNKI) platform, indicating that "employee performance commitment" has become a hot topic in academic research. Meanwhile, in practical management, many enterprises require employees to develop annual plans at the beginning of the next fiscal year. Among them, the most critical aspect is the formulation of performance goals for the next year by employees, which is called "employee performance commitment." Therefore, employee commitment to performance is crucial for enterprise management in both theory and practical operations. In the previous section, we have analyzed its significance in detail. In this chapter, we will start from this topic and specifically discuss the current research status on the impact of employee

performance commitment on corporate earnings management.

First, we should acknowledge the positive effects of employee performance commitments. According to Kohers, Ang, and other researchers who initially proposed signing employee performance commitment agreements, such agreements can prevent companies from exaggerating their strength during cooperation[5]. By putting commitments in writing, both parties can reduce information gaps and protect the interests of the market side. It is worth noting that, in their original idea, in addition to employee performance commitment agreements, both parties would also use performance compensation commitment agreements to balance their interests and maximize the incentives for companies to improve their performance. In 2014, Chinese scholar Zhang A. conducted specific empirical analysis based on previous theories [6]. By analyzing the acquisition process of specific companies in the market, he found that after the acquired company made employee performance commitments, the completion speed of both parties in the acquisition project was significantly higher than that of companies that did not make employee performance commitments. Therefore, it was concluded that employee performance commitments can reduce the transaction costs caused by the risks and information asymmetry faced by the acquirer during the acquisition process, ultimately enhancing the efficiency of acquisitions. Scholar concluded that employee performance commitments can deliver positive messages to the market and even allow the market to gain excess returns during the cooperation announcement period [7].

However, during the same period, many scholars also discovered some adverse effects of employee performance commitments: the corporate earnings management mentioned earlier. Corporate earnings management refers to deliberately manipulating a company's accounting earnings through methods such as falsification to cover up or embellish its true economic performance [8]. Early corporate earnings management mainly involved manipulating within a specific scope, using methods such as recognizing income in advance or deferring recognition of expenses to boost current earnings; later earnings management even extended to model-driven manipulation, such as excessive production or discretionary reduction of research and development expenses [9]. Regardless of the method, such behavior is like taking poison to quench thirst. It may temporarily deceive the market, consumers, or even relevant regulatory authorities, but it is highly detrimental to the company's long-term development. Moreover, severe corporate earnings management can alter the company's regular business decisions and negatively impact the company's future operations. Operations involving illegal practices may also be subject to administrative penalties by regulatory authorities [10].

3. The Impact of Employee Performance Commitment and Corporate Earnings Management Based on the Decision Tree Model

3.1 Application of the Decision Tree Model in Enterprise Management

To avoid inappropriate earnings management by the company due to employees committing to excessively high-performance targets for the fiscal year, enterprise management must find the most suitable standard for employee performance commitment. Traditional methods usually rely on analyzing past data to roughly estimate a number, but this approach may also include some employees who set unrealistic and unattainable targets. In such cases, managers often have difficulty finding effective solutions, and they may not even recognize the unrealistic performance goals set by employees. This study introduces the decision tree model with innovation. By mining historical data of the company and industry data, the decision tree model aims to find a fitting curve between employee performance commitment and corporate earnings management, enabling precise predictions. As the foundational algorithm for this research, the decision tree model has also been previously applied in enterprise management.

The decision tree model involves calculating the probability of all possible events and arranging them in a tree-like format to form a decision tree. By utilizing data analysis methods, the expected net present value is calculated, and the probability greater than zero is used to evaluate project risk and assess decision feasibility. The decision tree model is an intuitive graphical method of applying probability analysis in mathematics, and with the development of machine learning, it has been widely used in enterprise management. Figure 1 demonstrates how the decision tree calculates the probabilities of two scenarios and selects the optimal solution.
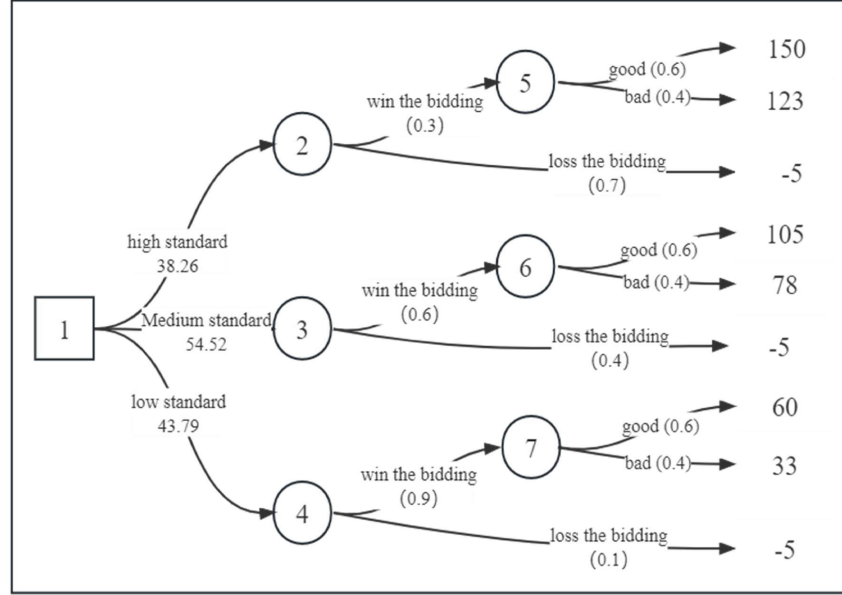

Figure 1. Application Example of Decision Tree in Enterprise Management Decision

The commonly used decision Tree model is the ID3 algorithm. The decision tree is formed by selecting the attribute with the most significant information gain as the extended attribute. The model-building formula is shown in Formula 1 to 2.

$$H(X,C) = H(X) = -\sum_{i=1}^{n} p(C_i) \log_2 p(C_i)$$

(1)

$$H(X|a) = -\sum_{i=1}^{n} \sum_{j=1}^{m} p(C_i, a = a_j) \log_2 p(C_i | a = a_j)$$

(2)

3.2 The Relationship between Employee Performance Commitment and Corporate Earnings Management in Mergers and Acquisitions

Mergers and acquisitions (M&A) are the primary contexts where employee performance commitments occur, and the conditions and backgrounds are more complex than in general cases. To better demonstrate the effectiveness of the algorithm presented in this paper, we directly study the impact of employee performance commitment on corporate earnings management in M&A scenarios. The selected dataset consists of M&A cases in the market from 2009 to 2022. After cleaning the data by performing necessary operations, 5914 M&A samples were chosen. Continuous variables were subjected to Winsorizing to retain the accuracy of the initial data by capping the values at the 1% upper and lower tails.

With the cleaned data, a decision tree model was constructed. In this study, we used the absolute value of real earnings management as the dependent variable to measure the level of corporate earnings management. The employee performance commitment period and the commitment amount were used as independent variables. Other factors, such as firm size, leverage ratio, return on assets, revenue growth rate, asset turnover rate, ownership structure, and audit quality, were treated as control variables to build the decision tree model. The specific model formulas are shown in formulas 3 to 5.

$$\left|REM\right| = \alpha_0 + \alpha_1 Per + \alpha_i Control_i + \varepsilon \qquad (3)$$

$$\left|REM\right| = \alpha_0 + \alpha_1 LnCPA + \alpha_i Control_i + \varepsilon \qquad (4)$$

$$\left|REM\right| = \alpha_0 + \alpha_1 Type + \alpha_i Control_i + \varepsilon \qquad (5)$$

After visualizing all the data, we observed that the maximum and minimum values of real earnings were not equal to zero, indicating that all the selected company samples exhibited earnings management behavior. In addition, 47.8% of the companies were still in the performance commitment period, suggesting that at least half of the companies engaged in mergers and acquisitions signed employee performance commitment agreements. Lastly, upon analyzing the data, we found that nearly one-third of the samples did not meet the performance commitments set by the employees. Still, they also did not employ evident corporate earnings management practices. Further data analysis revealed that indeed 32.1% of the companies, while failing to achieve the performance commitments, employed the agreed compensation methods during the mergers and acquisitions process to compensate for the unachieved performance. The main compensation methods were the "stock + cash" method, the stock method, or a combination of both.

Next, we introduced the breadth information entropy to verify the specific relationship between performance commitments and corporate earnings management. We established a fuzzy set Hartley measurement model to generalize the relationship in a fuzzy environment while considering the impact of different degrees of fuzziness among different companies, which is typically considered in corporate management. The specific formulas are shown in formulas 6 and 7.

$$H_1(A) = \log_2 \sum_{i=1}^{n} A(x_i) \qquad (6)$$

$$H_2(A) = \int_0^1 \log_2 \left|A_\lambda\right| d\lambda \qquad (7)$$

Through constructing the decision tree model, we have established a fuzzy set whose level-cut set can be used to depict the essential characteristics. The level of the cut set reflects the fitting gap between simulated situations and actual situations. Based on the degree of agreement between the two, the credibility of the decisions made can be confirmed. Therefore, during employee performance commitments, the target guidance can be conducted. The specific results are shown in Figure 2. From Figure 2, we can see that the level of the cut set increases with the increase of the level, which means that as the deviation between employee performance commitments and theoretical values becomes larger based on our model, the probability of the company's interference through earnings management also increases. This indirectly proves that employee performance commitment behavior can, to some extent, elevate the company's real earnings management level.
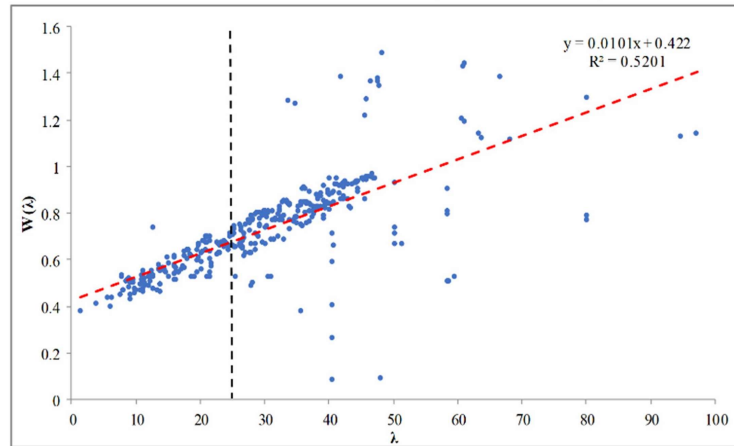
Figure 2. Illustration of the Function of Level-Cut Sets

After demonstrating the model's validity, we needed to analyze its performance through examples. Therefore, in subsequent research, we took a certain company in the market as an example and compared the classical decision tree model with the model proposed in this paper in terms of characteristics and performance, such as tree size and rule size, to demonstrate the advantages of this model.

4. Instance Analysis and Results

Based on the research conclusions above, we simulated and analyzed real market data. We selected XX Smart Enterprise as the research subject and analyzed the employee performance data disclosed in the company's merger and reorganization-related documents and financial reports. Upon preliminary data examination, we found that the company's employee performance commitments led to a significant financial loss of over 2.7 billion yuan in 2020, equivalent to twice the net profit from 2016 to 2019. However, during the actual merger and reorganization process, the company's acquisition price was significantly higher than that of two other companies with better performance. Therefore, we speculated that the company might be engaged in earnings management during the performance commitment period. After collecting and preprocessing the data, we analyzed the company's cash flow and historical financial data to judge and identify its real earnings management behavior from various angles. The specific results are shown in Figure 3.

Figure 3 shows that the traditional decision tree method predicts a significant fluctuation in the relationship between XX company's employee performance commitments and earnings management among the five compared variables. Therefore, compared to the predictions of the traditional decision tree method, the results of the decision tree method proposed in this paper are more robust in all aspects. In addition, we found that the relationship between the two is significantly evident at the 0.1 and 0.5 levels for the Type and Size variables, respectively, indicating that the results are correct with 99% and 95% confidence, further validating the reliability of this decision level.

Based on the research above, we can conclude that the company may adopt earnings management measures or other disguises to ensure positive profitability during a period of severe cash flow shortage to meet employee performance commitments. However, it is not ruled out that the company may use cost reduction and efficiency

improvement methods, such as layoffs, reducing research and development costs, or even fabricating actual profit levels to avoid market and consumer loss of confidence and damage to the company's image. By applying this result to the decision tree level function, we can determine that the optimal employee performance commitment level is around 30%, which minimizes the possibility of earnings management by the company.
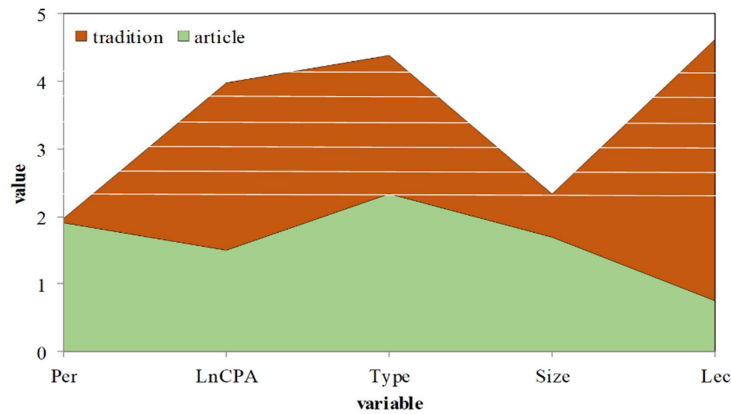

Figure 3. Decision Tree Regression Results for XX Enterprise

5. Conclusions

In summary, this paper started with the current research status of employee performance commitments and enterprise earnings management. It introduced the role of the decision tree model in exploring the relationship between the two. It also innovated on the traditional decision tree model by using the generalized entropy increase algorithm to reduce prediction errors. Finally, by using actual data from XX Smart Enterprise as an example, the model was validated, and it was found that the company engaged in inappropriate employee performance commitments, leading to earnings management practices. The research conclusions of this paper also provide some insights to relevant parties. When signing employee performance commitment agreements in mergers and acquisitions, the acquiring party should set reasonable goals to avoid such self-destructive earnings management behavior. For the acquiring party, a cautious judgment of the acquired company's situation is essential, and the employee performance commitment should not be the sole criterion for judgment. A comprehensive consideration of past employee performance commitments, current cash flow situation, and company records is necessary to minimize risks.

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