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DETERMINING THE OPTIMAL NUMBER OF BOARD MEMBERS: IMPLEMENTATION OF ARTIFICIAL NEURAL NETWORKS

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ABSTRACT

Purpose- The goal of this research is to delve into the complexities of board structure and composition within firms. Specifically, it aims to examine how various factors such as firm performance and firm-based play a role in determining the most appropriate number of board members.
Methodology- A neural network model is created to identify the ideal number of board members based on financial performance metrics. Financial performance indicators (return on assets, return on equity, profits per share, and market to book value ratio) and firm-based variables compose the model's input layer (company age, company size, total sales, and leverage). The output layer displays the ideal number of board members for each organization. The model's design has one or more hidden layers to represent the intricate interactions between the input variables and the desired output.
Findings- As compared to the other factors, the significance of the return on assets variable as a predictor is much higher. At least one of the intervals is affected by each of the eight factors, and each of those eight variables has a statistically significant influence.
Conclusion- Through a comprehensive analysis and review of existing literature, the study intends to shed light on the interplay between these factors and their impact on board effectiveness and decision-making. By exploring the relationship between firm-based factors and board composition, the research hopes to provide valuable insights and recommendations for firms looking to optimize their governance structure and improve their overall performance.

Keywords: Board size, optimal number of board members , artificial neural network, return on assets.
JEL Codes: M40, M41, C45

1. INTRODUCTION

Corporate governance plays a crucial role in the success and sustainability of organizations across various industries (Kocmanová, et al., 2011). The composition and efficiency of a company's board of directors significantly influence its overall performance and strategic direction. One critical aspect of board composition is determining the optimal number of board members to effectively manage the organization and make informed decisions (Raheja, 2005). Striking the right balance between having a diverse range of expertise and maintaining efficient decision-making processes is paramount to the success of a company.

The use of artificial intelligence, particularly artificial neural networks (ANNs), has gained momentum in recent years as a reliable tool for solving complex problems and optimizing various processes. ANNs, inspired by the biological neural networks found in the human brain, are capable of learning and adapting to new data, making them ideal for analyzing intricate relationships between variables (Zakaria et al., 2014). Implementing ANNs in the context of determining the optimal number of board members has the potential to provide valuable insights, leading to more effective and robust corporate governance structures (Karami and BeikBoshrouyeh, 2011).

The primary objective of this study is to identify the most effective factors for determining the ideal number of board members through the implementation of artificial neural networks. This research aims to use various data sources to evaluate the optimal number of board members for different companies. It also aims to examine how various factors such as firm performance (return on assets, return on equity,

earnings per share, and market to book value ratio) and such as firm based company size, company age, total sales and leverage play a role in determining the most appropriate number of board members. By analyzing these key factors using advanced machine learning techniques, this study aims to provide valuable insights into enhancing corporate governance practices and improving overall organizational performance.

2. LITERATURE REVIEW

The decision to increase the number of board directors is not a simple one, as it comes with both costs and benefits (Boone et al., 2007). On one hand, adding more directors could bring in fresh perspectives and diverse experiences, leading to better decision-making and improved company performance (Larmou and Vafeas, 2010; Cheng, 2008). On the other hand, it also means more people to compensate, more opinions to consider, and potentially longer and less efficient meetings (Hahn and Lasfer, 2016). Ultimately, the decision should be carefully weighed and evaluated based on the specific needs and goals of the company.

In many countries, policy makers and regulators are constantly seeking to improve the effectiveness of boards. One common approach they have taken is to discourage the formation of large boards (Boozang, 2007). This is because large boards can often lead to complex decision-making processes, with too many voices and opinions being considered (Chen and Al-Najjar, 2012). Smaller boards, on the other hand, can often lead to greater efficiency and accountability (Yermack, 1996; Abdul Manaf et al., 2014). Therefore, many countries have implemented regulations that encourage companies to maintain smaller, more streamlined boards.

The ability of boards to monitor and advise is directly proportional to their size. This is because with a larger board, there are more diverse perspectives and experiences to draw upon (Cheng, 2008). This can result in more robust discussions and better decision-making. Additionally, a larger board can provide a wider network of connections and resources to support the organization (Lin and Lee, 2008). However, it's important to note that the effectiveness of a board doesn't solely depend on its size, but also on the quality of its members and their willingness to work together towards a common goal.

Despite the importance of having an effective board of directors, little research has been done on the optimal number of board members. Academic studies and regulatory bodies, which often provide guidelines for corporate governance, have yet to conduct a thorough analysis on this topic. As a result, companies may struggle with determining the appropriate number of board members to ensure strategic decision-making, effective oversight, and diverse perspectives.

3. METHODOLOGY

The methodology employed in this study is designed to investigate the optimal number of board members for companies, taking into account various financial performance and firm-based indicators. The following sections outline the data collection, preprocessing, and analysis techniques used in the study.

Data Collection - The data set for this research consists of information from a diverse range of companies across different sectors, collected on a yearly basis. The primary variables of interest include the number of board members and financial performance indicators, namely return on assets, return on equity, earnings per share, and market to book value ratio. In addition, four firm based variables are considered: company age, company size, total sales, and leverage. Data is obtained from publicly available financial reports and company filings.

Data Preprocessing - Before analysis, the data is subjected to preprocessing steps to ensure its quality and suitability for the ANN model. This involves handling missing values, removing outliers, and standardizing the data to minimize any potential biases in the analysis. All variables are also transformed as necessary to improve interpretability and facilitate comparison between companies of different sizes and ages.

ANN Model Development - To determine the optimal number of board members based on financial performance indicators, an artificial neural network model is developed. The input layer of the model consists of the financial performance indicators (return on assets, return on equity, earnings per share, and market to book value ratio) and firm based variables (company age, company size, total sales, and leverage). The output layer represents the optimal number of board members for each company. The model's architecture includes one or more hidden layers to capture the complex relationships between input variables and the target output.

Model Training and Validation - The data set is split into a training set and a validation set, with the training set used to train the ANN model and the validation set employed to evaluate its performance. The model is trained using gradient descent optimization and backpropagation algorithms, adjusting the weights and biases iteratively to minimize the error between predicted and actual optimal board sizes. The model's hyperparameters, including the number of hidden layers, neurons, activation functions, and learning rate, are fine-tuned through a systematic grid search or other optimization techniques to ensure the best possible performance.

Model Evaluation - Once the ANN model is trained, its performance is evaluated on the validation set. Key evaluation metrics, such as mean absolute error (MAE), mean squared error (MSE), and the coefficient of determination (R^2), are used to assess the model's accuracy and predictive capabilities. The model's performance is compared with that of other machine learning algorithms or traditional statistical models to demonstrate the benefits of using ANNs for this problem.

Sensitivity Analysis - To further understand the impact of the input variables on the optimal number of board members, a sensitivity analysis is conducted. This analysis aims to identify the most influential variables in determining the optimal board size and to explore the nature of

their relationships with the output. Sensitivity analysis results can provide valuable insights into the key factors driving board composition and inform decision-makers on areas that warrant closer attention when determining board size.

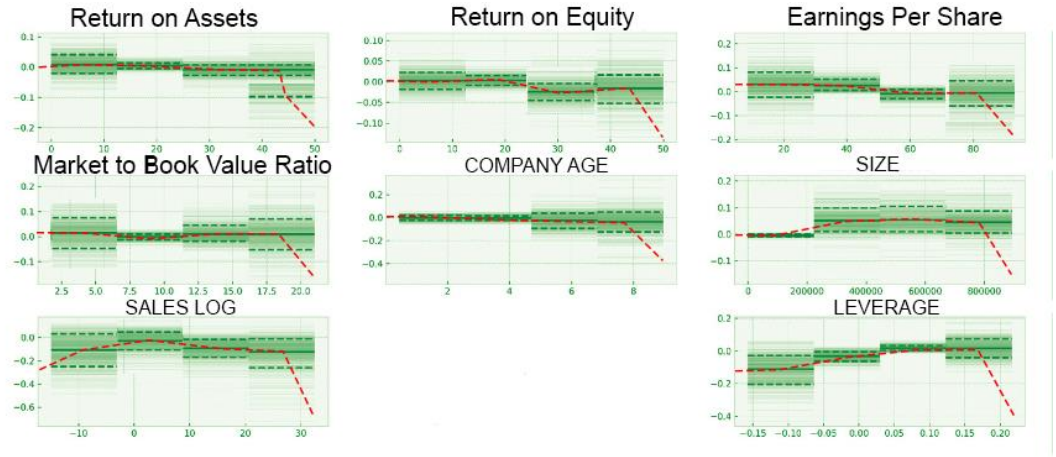
Limitations and Assumptions - The methodology employed in this study is based on several assumptions, including the assumption that the financial performance and firm-based indicators accurately represent the company's performance and characteristics. It is also assumed that the relationships between these variables and the optimal number of board members are consistent over time. Moreover, the study's findings may be subject to limitations arising from the sample size, data quality, and potential biases in the ANN model. In this study, a total of 4 different ANN models were used. A total of 8 different variables were added to the analysis within the study.

The findings of the ANN study are shown in Table 1. According to the findings presented in Table 1, return on assets is the most significant predictor, with a maximum effect difference of 0.237. return on equity intensity came in second, with a maximum effect difference of 0.165. The features of the board were shown to be more important predictors of the optimum number of board member, as indicated by the findings.

Table 1: The average impact that each variable has on the model's ability to forecast the optimum number of board member

Variable	*Maximum effect difference*
Return on Assets	1.958
Return on Equity	1.269
Earnings Per Share	0.389
Market to Book Value Ratio	0.369
COMPANY AGE	1.894
SIZE	0.679
SALES LOG	0.098
LEVERAGE	0.059

Figure 1: The mean impact for the prediction



Continuing on with the model for the ANN-based variable analysis, we continue. The statistical analysis of the model's relevance may be seen in Figure 1 and Table 2. As compared to the other factors, the significance of the return on assets variable as a predictor is much higher. At least one of the intervals is affected by each of the eight factors, and each of those eight variables has a statistically significant influence. Table 2 shows that ANN's analysis of the relative relevance of the factors. To mitigate these limitations, robustness checks are performed to test the validity and reliability of the results.

Table 2: ANN's analysis of the relative relevance of the factors

Variable	*First ANN*	*Second ANN*	*Third ANN*	*Fourth ANN*	*Maximum Effect*
Return on Assets	0.268	0.169	0.367	0.145	0.237
Return on Equity	0.148	0.134	0.214	0.167	0.165
Earnings Per Share	0.036	0.019	-0.028	0.048	0.018
Market to Book Value Ratio	0.028	0.017	0.027	0.069	0.035
COMPANY AGE	0.194	0.148	0.158	-0.139	0.141
SIZE	0.147	0.217	0.169	-0.016	0.020
SALES LOG	0.014	0.009	-0.018	-0.056	-0.012
LEVERAGE	0.005	-0.019	-0.036	0.064	0.003

4. CONCLUSION

Despite extensive research in the field of corporate governance, the literature is notably lacking a study on the optimal number of board members that a company should have. Despite the lack of research, some experts believe that having too many board members can lead to inefficiencies and decision-making challenges, while having too few can result in insufficient perspectives and scrutiny. Thus, further research is necessary to determine the ideal number of board members for a company to achieve the best outcomes.

The research aims to investigate and evaluate the different factors that contribute to determining the optimal number of board members for a firm, such as firm performance, size, and structure. Through a comprehensive analysis and review of existing literature, the study also intends to shed light on the interplay between these factors and their impact on board effectiveness and decision-making. By exploring the relationship between firm-based factors and board composition, the research hopes to provide valuable insights and recommendations for firms looking to optimize their governance structure and improve their overall performance.

In spite of the fact that our ML technique has numerous advantages over conventional econometric models, it nevertheless has several disadvantages in common with these models. For instance, despite the fact that our model contains a comprehensive list of company and board characteristics, we are unable to rule out the possibility of endogeneity due to the presence of omitted variable bias. In addition, in the same way that standard econometric models are unable to address questions regarding causation, so too is our research. Yet, the first essential step is to demonstrate that the relationship seems to be present in the data after having a thorough understanding of the possible origins of this link. Finding connections between the many factors that have been looked at and determining the relative relevance of those links is the primary focus of our study. For the sake of our investigation, we are mainly interested in making use of ML as a descriptive tool that may identify patterns in the data without hypothesizing any specific theory. As a result, the results of our study indicate significant discoveries that might direct researchers in the identification of crucial factors that have to be incorporated in theoretical models in further research.

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