

## Research Article

# Multivariate Analysis for Overcoming Complexities of Corporate Governance and Managerial Dilemma Using Data Mining Techniques

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The increased number of corporate dirty pools raised serious concerns about the interest of the shareholders. The board room politics, conflict of interest, and bully pulpit proclivity gave birth to the “agency complexities.” The complexities of the corporate world made a buzz for the serious thoughts on corporate governance. This analysis aims at an objective and scientific inquiry about the relationship between corporate governance complexities and firm performance by utilizing data mining tools. It aims at overcoming the corporate dilemma over profitability vs. good governance and presenting a scientific model to eradicate the complexities in the corporate governance system and aims at providing a scientific basis to overcome the complex issues of governance faced by the corporate. The multivariate analysis in this paper utilizes a data mining tool for regression analysis and ANOVA. This paper also proposes a mathematical model that supports the study outcomes. The investigation outcomes are not only backed by the mathematical model and scientific tools but also by a comprehensive comparative analysis. The outcome of the investigation clearly mentions the significance and the primacy of each variable in the corporate decisions making process, which will facilitate the organizations in framing their corporate governance policies and will also be helpful to the managers in overcoming the corporate dilemma faced by them.

## 1. Introduction

The advent of a new era of science, technology, and information revolution paved the way for several structural and regulatory reforms around the world. The great journey of trade and commerce from barter to sole trader and to the gigantic multinational corporations is like a metamorphic transformation of a caterpillar into a beautiful butterfly. This transition played a pivotal role in the genesis of the complex organizational structures which further led to operational framework failures, frauds, and unethical business practices. The increased number of corporate dirty pools raised serious concern about the interest of the investors. “Corporate dirty pools” is a comprehensive term used for insider trading, tunneling, and window dressing. It includes intentional

implementation of a lame corporate governance framework, poor risk mitigation policies, fraudulent accounting practices, and fabricated financial reporting.

Accountability, truth and fairness, responsibility, transparency, and disclosure are some of the founding principles of corporate governance. Adherence to higher standards of corporate governance standards involves a cost to the organization. Harvard law school forum on corporate governance, in their report on global and regional trends in corporate governance for the year 2022 has mentioned the climate change and increased demands of assertive investors for sustainable ways of doing business (Fields et al.). Implementing the provisions related to financial reporting and disclosures on sustainability efforts of management for tackling the climate change challenges and simultaneously

fixing the responsibility and accountability of directors and executives for the climate risk oversight are some of the biggest contemporary challenges of corporate governance. Many regulations and standards in this context have already been merged into the International Sustainability Standards Board (ISSB) under IFRS. The pressure for decarbonizing the globe is higher than ever before in the corporate sector. The decision of complying with sustainability standards impacts the profitability of a company negatively, as it is a “costly affair” for any organization. The poor financial performance of the company questions the efficiency and effectiveness of management. This is one of the typical cases of an ethical dilemma for the managers in which they have to choose between good corporate governance that advocates environmental sustainability or profitability.

The board room politics, conflict of interest, and bully pulpit proclivity gave birth to the “agency problems.” The term “bully pulpit proclivity” refers to the management’s unethical acts. It includes running a self-inclined agenda at the cost of investors’ interest and misusing their powerful positions for whitewashing their acts in the public domain. All these collectively increased the complexities of corporate governance and gave a buzz to serious thoughts on the issue. Though the stringent laws and regulative framework endeavors investors protection, but in the recent past a number of corporate swindles unnerved the measures taken by the government to strengthen corporate governance. An abyssmal downfall of corporate ethics and morality alarmed the world to rethink this complex governance issue and come up with a better and stronger governance mechanism.

This corporate pandemonium drew the attention of many researchers and academicians around the globe. The archive is flooded with various empirical and descriptive studies on this complex matter. Each investigation has its own pattern and different outcomes. There are some studies that reveal a positively significant relationship between corporate governance and firm performance; some studies reveal a negative and insignificant relationship; and a few studies even show the mixed result.

This study attempts at providing new dimensions to the investigation by focusing on the complexity of corporate governance issues. The relationships between the organizations and their stakeholders in general and the stockholders are highly complex in nature (Georgian et al.). The majority of the previous studies are based on two or maximum up to three corporate governance elements whereas, we have taken six independent variables as the components of corporate governance. Our study aims at an objective and scientific inquiry about the relationship between the complexities of corporate governance and firm performance. In this multivariate analysis, we have utilized various data mining tools such as SPSS, regression analysis, and ANOVA. We have also proposed a mathematical model which supports the study outcomes. The investigation outcomes are not only backed by the mathematical model and scientific tools but also by a comprehensive comparative analysis. For our investigation purpose the board composition (BO), ownership structure (OW), board remuneration (BOR), board and shareholders meetings (BM),

transparency and shareholders rights (TSR), and corporate governance policies of the firm (CGCP) are primarily taken as corporate governance components for measuring financial performance accounting-based parameter, i.e., return on capital employed (ROCE) is used. The study is based on the 121 small caps, mid-cap, and large-cap companies listed on the Bombay stock exchange (BSE). The data are collected through the Prowess database. The key contribution of the paper are as:

- (i) The study aims at providing a scientific basis to overcome the complex issues of governance faced by the corporate.
- (ii) We have applied a combination of data mining tools such as Support Vector Machine (SVM) with the help of Hyperplane. Data mining tools along with mathematical modeling make our methodology robust and study outcomes more rational and scientific.
- (iii) We have applied a multidimensional approach by focusing on key corporate governance variables in a single study.
- (iv) The outcome of the investigation clearly mentions the significance and the primacy of each variable in the corporate decisions making process, which will facilitate the organizations in framing their corporate governance policies and will also be helpful to the managers in overcoming the corporate dilemma faced by them.

## 2. Related Work

In the past decade, many researchers investigated corporate governance from various paradigms but failed to reach a common stand on governance and profitability association. Many authors discussed the complexities of modern organizational structures and the dynamics of corporate governance. The study outcomes differed with the change in the methodology, size of the company, and the governance framework of the countries. Some results advocated positive association, some revealed negative and nonsignificant associations and there are some which showed mixed results [1]. Manson and Zaman [2] also questioned the legitimacy of the controllers who are at the helm of affairs and yet only want to reap the benefits without being held responsible for their deeds. Another study by [3]; Kim and Lee [4] show that corporate governance has a strong positive impact on the firm’s performance. The study revolves around the East Asian financial crisis period, i.e., in the year 1997-98, that further glorifies the independent directors’ traditional role of improving and monitoring management.

Dwivedi and Jain [5] in their empirical analysis for the time-period of 1997–2001 on 340 Indian companies revealed a positive and significant association between corporate governance and firm performance. Board size and ownership were taken as the variables for corporate governance and firm performance was evaluated using Tobin Q. Similarly in another study based on Indian companies

Gupta [6] investigated the level of adherence to corporate governance norms in selected automobile companies and found that those automobile companies' policies and practices were in line with the regulatory framework of corporate governance in the country.

Monks and Minow [7] in their book titled corporate governance attempts to explain the significance of the practical applicability of corporate governance by using various real-life corporate examples. A study based on Iranian companies listed on Tehran stock exchange for the two consecutive financial years 2005 and 2006 by Mashayekhi and Bazaz [8] on the same issue by utilizing the regression analysis revealed that a larger board size will affect the performance of the company. They also strongly advocated the role of independent directors in improving the firms' financial out-turn.

Wang et al. [9] in their study based on 106 High techs, medium, and small-size Chinese firms found a positive relationship between ownership concentration and corporate performance. They also proved that the firms which have a greater number of board meetings take better decisions and they perform well. Furthermore, they state that there is a direct relationship between the board remuneration and corporate performance, i.e., the companies, which pay their director's good remuneration, perform better in terms of financial efficiency.

On the other hand, there are some studies that outrightly reject the premise of any type of significant association between good governance of corporate and firm financial efficiency. Some studies reveal a weak or insignificant relationship between corporate governance and the firm's performance. Bhagat et al. [10] in their study found no correlation between board independence and long-term firm performance. Similarly, another study by Bauer et al. [11] on European firms found a negative association between governance standards for corporate and the performance of the firms.

By using generalized linear model (GLM) Fauzi and Locke [12] proposed that the board, Board committees, managerial ownership, and block holding ownership have a positive influence on the firms' performance in New Zealand. The study results based on 79 firms in New Zealand were indicative of poor firm performance due to block holding ownership patterns and nonexecutive director's excessive interference.

Vo and Phan [13] in their research investigation based on Vietnamese firms found that Board compensation is positively associated with firm performance whereas Board size has a negative relationship with firm performance. It further advocated that there is no link between independent directors and a firm's performance. It shows a nonlinear relationship between ownership and corporate governance. The study utilized feasible generalized least square (FGLS) regression. Board size, board independence, and board remuneration were a parameter for corporate governance whereas the return on assets (ROA) was taken as representative of a firm's performance.

Moscu [14] In their investigation based on Romanian companies utilized debt-equity ratio as the firm efficiency

yardstick and board characteristics as corporate governance parameters and utilized regression analysis to investigate the relationship between them. Their research outcome revealed a direct relationship between board sizes and firm performance. It implies that the larger the board size better is the firm's output. On the other side nonexecutive directors (NED) and firm performance were found negatively associated. On similar lines, in a study on the firms in the life science sector in Canada, Cook [15] propounded that nonexecutive directors have minimal influence on a firm's efficiency.

Kim and Kim [16] in their study on governance social responsibility and credit rating found that corporate social responsibility and corporate governance have a positive impact on the firm's credit rating. Higher the corporate social responsibility and corporate governance scores better is the credit rating of the firm and vice versa. Another study on a similar line found a direct association between corporate governance and firm performance, Jaser and Quasim [17] applied regression analysis on 281 firms listed on Abu Dhabi stock exchange (UAE). They have used return on assets (ROA) and Tobin Q as the parameters for the firm's performance.

Kandukuri et al. [18] in their study on Indian companies found similar results. The study results revealed the imbrications of private companies over public companies globally. Al-Gamrh and Ku Ismail [19] in their research investigation found that return on equity and profitability were not associated with the corporate governance variables. But overall corporate governance had a positive influence on the performance of the firm. The study covered 20 companies in the Indian manufacturing sector.

Naimah and Hamidah [20] in their research found that board audit committee meetings and quality of audit were directly related to the profitability of the company, whereas leverage, board independence, and size of the company were indirectly associated with the profitability of the company. The authors utilized regression analysis for the study.

Ilham et al. [21] in their investigation of the Turkish companies found that corporate governance and performance of the firms were positively associated. The study outcomes are suggestive of a significantly positive relationship between ownership concentration and board size. On the other hand, Balagobei [22] in her study based on Sri Lankan firms found smaller board sizes more suitable for better firm performance. The study also found a negative impact of the audit committee on the firm's performance.

A study based on Sri Lankan financial institutions Danoshana and Ravivathani [23] found that the size of the board and audit committee matters. Larger the size of the board and audit committee better the performance of the company but, on the other hand, frequency of the board meetings were found to be indirectly associated with the firm performance. It means that the firms having a greater number of board meetings did not perform financially well. Another study by Bhagat and Bolton [24], which is a sequel of their previous investigation in the year 2008 on corporate governance and firm performance took the data for the period of 2003 to 2016. Based on the long-term analysis the

study results suggested that director stock ownership helped in improving the performance of the firms and helped risk mitigation as well.

Similarly, Bijalwan et al. [25] in their exploratory analysis of corporate governance using supervised data mining tools found that there is a significantly positive relationship between board meetings and firm performance. They found that the firms with a greater number of board meetings performed better as compared to the firms with a lower number of board meetings. The study outcomes further showed that the remuneration paid to directors had no effect on the firm performance.

The recent study based on the firms listed on Abu Dhabi stock exchange (ADX) in the United Arab Emirates (UAE) by Al-Gamrh et al. revealed that more investment opportunities lead to poor firm performance. The study characterized UAE firms with lame corporate governance practices. The study further mentions that stronger corporate governance helps in mitigating the negative impact of investment opportunities. Malhotra et al. [26] on 242 companies listed on Bombay stock exchange (BSE) for the period of 2015 to 2019 that consisted of both public sector and private sector firms found that the public sector firms had a better corporate governance practice as compared to the private sector firms in India.

Fatma and Chouaibi [27] examined the impact of the characteristics of two CS mechanisms, i.e., board of directors and ownership structure. It is based on the firm value of European financial institutions. Salehi et al. [28] aimed to measure the relationship between corporate sectors and managerial entrenchment in companies listed on Tehran stock exchange. They used panel data regression to test the hypothesis. Almaleki et al. [29] aimed to investigate the comparability between the impact of managerial pride and overconfidence on financial statements. Velte [30] showed the link between corporate governance and corporate financial misconduct. Guluma [31] aimed to investigate the impact of CG that measures on firm performance and the role of managerial behavior in the relationship between CG mechanism and firm performance. This analysis was based on Chinese listed firms.

Li and Nguyen [32] focused on small and medium-sized enterprises in emerging economies. Their study aimed at the impact of CG on firm value by exploring the mediation mechanism of CSR and organizational identification aligned with CG and firm value. Almaleki et al. [33] aimed to seek the potential impact of board member's characteristics, the level of the firm's CSR. They found from their study that in Iran innovation is willing to be transmitted into firms by industry sources though, In Iraq regardless of the industry index, a positive association between interlocked bounds and firm innovation is established. Their analysis also depicts that board interlock is not considered a mechanism to transmit information about CSR.

There have been many studies in the past covering corporate governance issues from various dimensions which applied either market-based or accounting-based parameters on standard governance key components. Most of the studies utilized two or maximum up to three variables with

the standard statistical tools to investigate the nature and degree of relationship among governance variables. Our study is based on the six key components of corporate governance such as board composition (BO), ownership structure (OW), board meeting (BM), board remuneration (BOR), corporate governance codes and policies (CGCP), transparency, disclosure, and shareholders rights (TSR). In this study, corporate governance variables are independent variables, whereas the return on capital employed is used as a dependent variable for determining the financial efficacy of the firm.

After an intense analysis of the literature on the subject, finally, the null hypothesis was developed, whose validity was subjected to a robust scientific investigation.

H0: There is no significant relationship between corporate governance complexity variables and the firm's financial efficacy.

### 3. Study Design

*3.1. Variable Selection and Model Construction.* The study uses corporate governance complexity as the independent variable which is made up of six different components viz. board composition (BO), ownership structure (OW), board meeting (BM), board remuneration (BOR), corporate governance codes and policies (CGCP), transparency, disclosure, and shareholders rights (TSR). Whereas firm's performance is a dependent variable which is denoted by return on capital employed (ROCE). Some other factors such as size of the firm (TA), Leverage (LEV), Liquidity (COR) of the firm, and Inventory turnover (IR) are taken as control variables for the study.

*3.1.1. Independent Variables.* The description of key components of the corporate governance complexity used as an independent variable is described in table no 1. Table 1 includes an explanation of the independent variables, their indicators, description thereof, and the symbolic representation for the validation through a mathematical model.

*3.1.2. Dependent Variable.* Firm's financial efficacy is the dependent variable for the study. In the previous studies on corporate governance, the financial efficacy of the firm was majorly assessed via market-based measures or accounting-based parameters. This study utilizes the accounting-based ratio, i.e., return on capital employed (ROCE) as a yardstick to measure the financial efficacy of the firm. ROCE is a financial ratio that can be expressed as earnings before interest and tax/capital employed. An ideal ROCE is one, that is, greater than the cost of borrowings of the firm.

*3.1.3. Control Variables.* Sizes of the firm, leverage, liquidity condition, and inventory ratio are taken as the control variables for the study. Size of the firm is measured according to the total assets held by the company; leverage condition is determined by the debt-equity ratio. For assessment of the liquidity condition of the company, liquidity

TABLE 1: Independent variables.

Sr.no.	Factors	Indicators	Description	Symbolic
1	Board composition (BC)	(a) board size (b) board independence	(a) total no. of BOD sitting on board (b) ratios of DIRs to ID and ED to NED etc	$x$
2.	Ownership structure (OS)	Ownership structure	Percentages of shares held by various stake holders in the company	$u$
3.	Board meetings and share holders' meetings (BSM)	(a) board meetings (b) shareholders meetings	(a) Total no. of board meetings held during the year (b) Total no. of shareholders meetings held during the year. (including provisional meetings)	$v$
4.	Board remunerations (BR)	Board remunerations	Remuneration paid to the top 3 executives in their natural algorithm	$w$
5.	Corporate governance codes and practices (CGP)	Corporate governance codes and initiatives	Corporate governance codes and initiatives are taken by the company	$z$
6.	Transparency and shareholders rights (TSH)	(a) Transparency and disclosure (b) Shareholders rights.	(a) transparency and disclosure norms followed by the company. (b) right to shareholders	$t$

TABLE 2: Control variables.

SN	Control variables	Explanation	Symbol
1	Size of firm	Total assets	TA
2	Leverage	Debt/equity	LEV
3	Liquidity	Current assets/current liabilities	COR
4	Inventory turnover	Cost of goods sold/average inventory	IR

ratios are utilized and Inventory turnover is measured with the help of inventory turnover ratio. Table 2 shows control variables utilized for the study.

3.1.4. *Model Development.* For making the methodology more robust we have proposed two different models. First model is a conceptual support vector machine (SVM) mathematical model which fits a hyperplane for testing the research outcomes as mentioned in below equation:

$$y = a + bx + cu + dv + kw + fz + gt, \tag{1}$$

where  $x, u, v, w, z,$  and  $t$  are independent variables as explained in the Table 1 and  $y$  is dependent variable. The second is an OLS regression model which investigates the relationship between corporate governance and firm's efficacy and is explained with the help of belowmentioned equation:

$$ROCE = \beta_0 + \beta_1BZ + \beta_2BO + \beta_3OW + \beta_4BM + \beta_5BOR + \beta_6TSR + \beta_7CGCP + \epsilon, \tag{2}$$

where the Board size (BZ), Board composition (BO), Ownership structure (OW), Number of Board and shareholders meetings (BM), Board remuneration (BOR), Transparency and shareholders' rights (TSR), and corporate governance Codes and policies (CGCP) are the independent variables. In the equation Return on capital employed (ROCE) is the dependent variable.  $\beta_0$  is constant and  $\beta_1, \beta_2, \beta_3, \dots$  are regression coefficients.

3.1.5. *Sampling.* The dataset for study is derived from the Bombay stock exchange. The sample consisted of 121 companies, which are inclusive of the companies from all the brackets of corporate for the period of 2015 to 2020. For

maintaining the comprehensiveness of the sample stratified random sampling technique was utilized and the sample size was determined by using Cohen's formulae, i.e.:

$$\text{Cohen's } d = \frac{(M_2 - M_1)}{SD_{\text{pooled}}}, \tag{3}$$

$$\text{where } SD_{\text{pooled}} = \left( \sqrt{(SD_1^2 + SD_2^2)/2} \right).$$

3.1.6. *Measurement of Corporate Governance Scores (CGSs).* The corporate governance scores are measured by using a structured questionnaire consisting of 51 questions. The questions strictly adhere to the international benchmarks set for good corporate governance. The scorecard based on governance, management, accountability metrics, and analysis (GAMMA) was used for the corporate governance scores (CGS) and weights were developed for corporate governance factors (variables) used in the study. Each segment had an independent score for its subcomponent and weights were assigned to each factor.

## 4. Results and Discussion

First model Support Vector Machine (SVM) requires fitting hyperplane when  $y$  is a dependable variable and others are independent variables. In which:

$$y = a + bx + cu + dv + kw + fz + gt \text{ where } x, u, v, w, z, \text{ and } t \text{ are independent variables and } y \text{ is dependent variable.}$$

Let us explain the proposed model with the help of hyperplane.

Put

$$x_1, x_2, x_3, \dots, x_m \text{ for } x.$$

$$u_1, u_2, u_3, \dots, u_m \text{ for } u.$$

$v_1, v_2, v_3, \dots, v_m$  for  $v$ .  
 $w_1, w_2, w_3, \dots, w_m$  for  $w$ .  
 $z_1, z_2, z_3, \dots, z_m$  for  $z$ .  
 $t_1, t_2, t_3, \dots, t_m$  for  $g$ .

$y_2, y_3, y_4, y_5, \dots, y_6 = a + bx_6 + cu_6 + dv_6 + kw_6 + fz_6 + gt_6$  where  $y_1, y_2, y_3, y_4, y_5$  and  $y_6$  are expected values of  $y$  with reference to  $(x_1, u_1, v_1, w_1, z_1, t_1), (x_2, u_2, v_2, w_2, z_2, t_2), \dots, (x_6, u_6, v_6, w_6, z_6, t_6)$

The values  $y_1, y_2, \dots, y_m$  are called observed values of  $y$  corresponding to  $x, u, v, w, z$ , and  $t$ . The expected values are different from the observed values. The difference  $y_r - y'_r$  for different values of  $x, u, v, w, z$ , and  $t$  are called residuals.

$$\sum_1^6 (y - y')^2. \tag{4}$$

By introducing a new quantity  $U$ , which is the sum of squares of residuals from 1 to 6.

$$U = \sum_1^6 (y_r - y'_r)^2 = \sum_1^6 [y_r - (a + bx_r + cu_r + dv_r + kw_r + fz_r + gt_r)]^2. \tag{5}$$

The constants  $a, b, c, d, k, f$ , and  $g$  are selected in a manner that sum of the squares of the residuals is minimum. After this the proviso for  $U$  to be maximum or minimum is as:

By simplifying the ratios, we got If  $\partial U / \partial a = 0$ , then  $\sum 2 (y_r - a - bx_r - cu_r - dv_r - kw_r - fz_r - gt_r) = 0,$  (7)

$$\frac{\partial U}{\partial a} = \frac{\partial U}{\partial b} = \frac{\partial U}{\partial c} = \frac{\partial U}{\partial d} = \frac{\partial U}{\partial k} = \frac{\partial U}{\partial f} = \frac{\partial U}{\partial g} = 0. \tag{6} \quad \text{or}$$

$$\sum y = ma + b \sum x + c \sum u + d \sum v + k \sum w + f \sum z + g \sum t \dots \tag{8}$$

By applying the same logic to

We have derived the Equations (10)–(15).

$$\frac{\partial U}{\partial a}, \frac{\partial U}{\partial b}, \frac{\partial U}{\partial c}, \frac{\partial U}{\partial d}, \frac{\partial U}{\partial k}, \frac{\partial U}{\partial f}, \frac{\partial U}{\partial g}. \tag{9}$$

$$\sum xy = a \sum x + b \sum x^2 + c \sum xur + d \sum vx + k \sum wx + f \sum zx + g \sum tx, \tag{10}$$

$$\sum yu = a \sum u + b \sum xu + c \sum u^2 + d \sum vu + k \sum wu + f \sum zu + g \sum tu = 0, \tag{11}$$

$$\sum yv = a \sum v + b \sum xv + c \sum uv + d \sum vv + k \sum wv + f \sum zv + g \sum tv = 0, \tag{12}$$

$$\sum yw = a \sum w + b \sum xw + c \sum uw + d \sum vw + k \sum ww + f \sum zw + g \sum tw = 0, \tag{13}$$

$$\sum yz = a \sum z + b \sum xz + c \sum uz + d \sum vz + k \sum wz + f \sum zz + g \sum tz = 0, \tag{14}$$

$$\sum yt = a \sum t + b \sum xt + c \sum ut + d \sum vt + k \sum wt + f \sum zt + g \sum t^2 = 0. \tag{15}$$

These would be taken as normal equations and can be solved for  $a, b, c, d, k$ , and  $f$ .

For  $a$ ,

$$\begin{aligned}
 & m \sum x \sum u \sum v \sum w \sum z \sum t - \sum y \\
 & \sum x^2 \sum xu \sum vx \sum wx \sum zx \sum tx - \sum xy \\
 & \sum xu \sum u^2 \sum vu \sum wu \sum zu \sum tu - \sum yu \\
 & \sum xv \sum uv \sum v^2 \sum wv \sum zv \sum tv - \sum yv \\
 & \sum xw \sum uw \sum vw \sum w^2 \sum zw \sum tw - \sum yw \\
 & \sum xz \sum uz \sum vz \sum wz \sum z^2 \sum tz - \sum yz \\
 & \sum xt \sum ut \sum vt \sum wt \sum zt - \sum t^2 \sum yt.
 \end{aligned} \tag{16}$$

Same can be applied to  $b, c, d, k, f,$  and  $g.$

$$D = \begin{bmatrix} m & \sum x & \sum u & \sum v & \sum w & \sum z & \sum t \\ \sum x & \sum x^2 & \sum xu & \sum vx & \sum wx & \sum zx & \sum tx \\ \sum u & \sum xu & \sum u^2 & \sum vu & \sum wu & \sum zu & \sum tu \\ \sum v & \sum xv & \sum uv & \sum v^2 & \sum wv & \sum zv & \sum tv \\ \sum w & \sum xw & \sum uw & \sum vw & \sum w^2 & \sum zw & \sum tw \\ \sum z & \sum xz & \sum uz & \sum vz & \sum wz & \sum z^2 & \sum tz \\ \sum t & \sum xt & \sum ut & \sum vt & \sum wt & \sum zt & \sum t^2 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \\ d \\ k \\ f \\ g \end{bmatrix}$$

$$= \begin{bmatrix} \sum y \\ \sum xy \\ \sum yu \\ \sum yv \\ \sum yw \\ \sum yz \\ \sum yt \end{bmatrix}. \tag{17}$$

The condition for U to be minimum is  $\partial^2 u / \partial a^2 \geq 0,$  for the given data.

It reveals that for the existence of  $a, b, c, d, k, f,$  and  $g$  variables it is a necessary and sufficient condition that a company will survive if cost function, i.e.,  $D \neq 0.$

Furthermore, in order to accomplish the research objective and to have a robust outcome, the null hypothesis was put to the test to check its validity. Various statistical tests were applied for a scientific and objective conclusion. To investigate the effect of corporate governance on the firm's efficacy, the regression analysis was applied to the dependent variables, i.e., Firm performance and the independent variables as components of corporate governance complexity as mentioned in Table 1. The investigation outputs are revealed as follows.

Table 3 shows the descriptive statistics for every component of independent variable. The mean represents the average value observed and the standard deviation reveals spread of the values and  $N$  is the number of firms utilized for study, i.e., sample size and min and max stands for the minimum and maximum usual values.

Table 4 is about Pearson's correlation coefficients of normally distributed data. The table is about the relationship between independent variables, i.e., corporate governance complexity components, and dependent variables, i.e., firm's financial efficacy parameter (Return on capital employed). Upon statistical investigation is observed that the correlation coefficient is 0.8210 between corporate governance codes and practices (CGCP) and transparency and shareholders' rights (TSR), which shows a positive relationship between the two components of independent variables. As the observed value is greater than 0.50 it can be said that the relationship between CGCP and TSR is very strong. Upon further analysis, it is observed that no other values were found to be significant as all of them were less than 0.50. The observed significance level or  $p$  value among these two variables also satisfies the condition of being strongly related as observed  $p < 0.001,$  which is less than 0.05. Hence, it can be strongly said that these two variables as strongly and positively correlated.

Table 5 is about model summary the superscript is about constants, i.e., corporate governance components utilized for the study such as board size, board composition, ownership structure, number of board and shareholders meetings, board remuneration, transparency and shareholders' rights and corporate governance codes and policies and  $b$  indicates a dependent variable, i.e., return on capital employed.

It also manifests about  $R, R$  square, adjusted  $R$  square, and standard error. The observed value of  $R$  in the proposed model is 0.822 which is within the boundaries of the regression analysis range, i.e., 0 -to 1. As the observed value of  $R$  in the given model is more than 0.5 it shows a very strong and positive relationship between independent variables and dependent variables. Furthermore, the value of  $R$  square is also high, i.e., 0.675 which falls within the range of 0 to 1 it suggests the goodness of the model to fit and accommodate the data well. The Adjusted  $R$  squared is 0.661 which further consolidates the claims of  $R$  Square.

Table 6 shows the ANOVA test results, it reveals the observed value of sum of squares, degree of freedom (Df), and mean squared for regression and residual. In the table regression outcome is shown as 9519.27 and the residual output is 4574.320 which shows both variations accounted and not accounted for the model, respectively. As it is evident that the sum square of regression output is more than the sum square of residual it means the model exhibits a higher level of variation in the dependent variable. This may need a supporting factor to facilitate the account for a higher degree of variation observed in the dependent variable. Furthermore, the observed  $F$  value is 47.86, which is derived by dividing regression mean square (1903.854) from residual mean square (39.77). The total number of degrees of freedom is the number of cases minus 1. The significance value of





TABLE 5: Model summary b.

Model	R	R square	Adjusted R square	Standard error	R square change	F change	Df1	Df2
1	0.822	0.675	0.661	6.306	0.675	47.864	6	114

TABLE 6: ANOVA.

Model	Sum of squares	Df	Mean square	F	Sig.
Regression	9519.27	6	1903.854	47.86	0.000
Residual	4574.320	114	39.77		
Total	14093.592	120			

TABLE 7: Coefficients.

	Unstandardized coefficients		Standardized coefficients Beta	T	Sig.	Correlations		
	B	Std. error				Zero-order	Partial	Part
(Constant)	2.255	15.63		0.144	0.886			
Board composition	0.050	0.061	0.078	0.821	0.413	0.106	0.077	0.075
Ownership structure	0.312	0.406	0.082	0.769	0.443	0.095	0.072	0.071
Board and shareholders meeting	-0.077	0.110	-0.073	-0.70	0.483	-0.019	-0.066	-0.06
Board remunerations	-0.052	0.063	-0.077	-0.81	0.415	-0.059	-0.076	-0.07
Corporate governance codes	0.058	0.136	0.069	0.424	0.672	0.119	0.040	0.039
Transparency and shareholders' rights	0.048	0.151	0.052	0.317	0.752	0.116	0.030	0.029

TABLE 8: Residuals statistics.

	Minimum	Maximum	Mean	Std. deviation	N
Predicted value	7.6527	24.7834	17.8812	3.08994	121
Residual	-2.02594E1	95.80276	0.00000	15.96239	121
Std. predicted value	-3.310	2.234	0.000	1.000	121
Std. residual	-1.237	5.850	0.000	0.975	121

$F \leq 0.001$ , which is much lower than the desired less than 0.05 condition.

As it is evident in Table 6, the observed residual value of 4574.320 is less than regression value of 9519.27 and the significant value of  $F \leq 0.001$  with this it can be concluded that the components of independent variables have done a good job in explaining the variations in the dependent variable.

Table 7 is about coefficients both standardized and unstandardized. In the given model the dependent variable (return on capital employed) = 0.050 board composition 2.255. Independent variables can be measured in different units. The standardized coefficients = 0.078 or betas try to make coefficients more comparable. The  $t = 0.144$ , which is less than +2 makes the value of regression more nonsignificant.

Table 8 is about residual statistics that explain the mean and standard deviations of predicted value, residual value, standard predicted value, and standard residual value.

By applying them to proposed OLS Regression model no I, we have derived the belowmentioned regression output for the model.

$$Y = 2.255 + 0.050 x + 0.312 u - 0.077 v - 0.052 w + 0.058 z + 0.048 t \dots\dots\dots 8, \tag{18}$$

where, Y = Return on capital employed x = Board composition u = Organization structure v = Board and Shareholders Meetings w = Board Remuneration z = Corporate governance policies t = Transparency and shareholders rights.

Many researchers have worked on the same issue in line with investigating the relationship between corporate governance and the firm's efficacy using different tools and techniques. Our contributions to the subject matter can differentiate in Table 9.

TABLE 9: Comparative table.

Related work	Point of difference											
	Neeraj Dwivedi and Arun Kumar Jain (2005)	Gupta (2006)	Zhen Yi Wang, Li Su and Ying Tang (2007)	Sanghoon Lee (2008)	Fauzi, F and Locke, S.C. (2012)	Cook, R. (2013)	Vo, D. and Phan, T. (2013)	Amare Mohammed Jaser, Quasim (2014)	Rajya Lakshmi Kanduri, Laila Memdani, P. Raja Babu (2015)	Akshita Arora, Chandan Sharma (2016)	Zahroh Naimah and Hamidah (2017)	Bijalwan J.G, Bijalwan. A
ANOVA	X	X	X	X	X	X	X	X	X	X	X	✓
Correlation	X	✓	✓	X	✓	X	X	✓	✓	✓	X	✓
Regression	✓	X	X	✓	X	✓	✓	X	X	X	✓	✓
Multivariate analysis	X	X	X	✓	✓	X	X	X	X	X	X	✓
Mathematical model	✓	X	X	✓	✓	X	✓	X	X	X	X	✓
Standard governance scoring scale	X	X	X	X	X	X	X	X	X	X	X	✓
Comprehensiveness of sample	X	X	X	X	X	X	X	X	X	X	X	✓
Positive relations	✓	✓	✓	✓	✓	X	✓	✓	✓	✓	✓	✓
Negative relations	X	X	X	X	X	✓	X	X	X	X	X	✓

## 5. Conclusion and Future Scope

In order to conclude the investigation, outcomes of both models need to be discussed one by one. In the case of the first proposed model which applies hyper plane reveals that for  $U$  to be minimum for the given data as:

$$\frac{\partial^2 u}{\partial a^2} \geq 0. \quad (19)$$

It refers that the existence of  $a, b, c, d, k, f,$  and  $g$  variables are a necessary and sufficient condition that a company will survive if cost function, i.e.,  $D \neq 0$ .

On the other hand, the second model utilized for study results into regression equation (8) which states that the board composition, corporate governance policies, and transparency have positive and significant relationship with firms' performance which is evident with the respective coefficients 0.050, 0.058 and 0.048. The coefficients of variables Board remuneration and Board meeting are  $-0.052$  and  $-0.077$  which shows a negative relationship with firms' performance. Furthermore, it can be said that the variables corporate governance policies and transparency and shareholders' rights are positively and significantly correlated with each other and do have a positive relationship with the firms' performance. A sound ownership structure is indicative of good firm performance on the other hand board and shareholders' meeting and board remuneration show negative coefficients  $-0.077$  and  $-0.052$ , respectively, which clearly evident a negative relationship with firms' financial efficacy. Our experimental results showed that the residual value of 4574.320 is less than regression value of 519.27 and the significant value of  $F \leq 0.001$  with this it can be concluded that the components of independent variables have done a good job in explaining the variations in the dependent variable.

In the nutshell, it can be said that both the models come to the same conclusion, and it can be strongly said that firms with sound board composition with adequate number of independent directors have a good impact on the firm's financial efficacy. Similarly, companies with good corporate governance policies and transparency in their financing and reporting produce better financial results. A sound organizational structure is a supportive factor in the long run. On the other hand, the company management shall abstain from spending excessive time and funds on board meetings and high perks and payouts to the directors as it is a futile expense and will not guarantee any returns. It can be said that for better financial rewards organizations must pay heed on complex corporate governance elements like board composition, sound governance policies, and transparency in their conduct and in handling the material facts.

"The might is right" approach is futile in the realm of good governance. Therefore, the managers and the directors should work in a positive and constructive frame of mind. They should keep the interest of the organization at the apex level of their priority list. It is quite evident from the outcome of both the models that the complexity of corporate

governance and the managerial dilemma of profitability vs. good governance can be overcome by balanced board composition, sound governance policies, and transparency in the organizational conduct. In conclusion it can be said that we have applied the multivariate model to study six independent variables however, the same mathematical model and machine learning approach can be applied for studying the relationship between  $n$  numbers of variables in the future [34–37].

## Data Availability

The source of the author's framework along with the datasets and analysis during the current study is already publicly available on <https://prowessiq.cmie.com/> which is maintained by CMIE. SPSS software was used for processing and classification purposes during the author's research experiment.

## Conflicts of Interest

The authors declare that there are no conflicts of interest.

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