Assessment

Determinants of CEO Salaries: A Cross-Sectional Analysis of Firm Characteristics

Student's Name

Course Name

Professor's Name

Date

Statement of the Research Problem

The pay of Chief Executive Officers (CEOs) has attracted attention in academic and public discussions. Despite extensive research, there's no agreement on the specific factors affecting CEO salaries. This research project aims to explore this issue, particularly examining the connection between CEO salaries and various firm characteristics. The available dataset offers a chance to investigate this problem, containing data on CEO salaries, percentage changes in salary from the prior year, firm sales in the prior year, average return on equity (ROE) and its percentage change from the prior year, average return on the firm's stock (ROS), and the type of firm (industrial, financial, consumer product, or utility). Each dataset row portrays a firm and its CEO, presenting a cross-sectional view of CEO salaries and the firms' accounting and financial positions.

The main focus of this project is to answer the research question: "What are the key determinants of CEO salaries?" More specifically, "How do firm sales, ROE, ROS, and the type of firm influence CEO salaries?" This inquiry will be addressed using descriptive and inferential statistical analyses. The results of this research may have noteworthy implications. If specific firm characteristics are identified as reliable indicators of CEO salaries, it could provide insights for compensation policies and practices. Additionally, it might contribute to the ongoing discussions surrounding executive compensation and income inequality.

Description of the Data and Descriptive Analysis

The dataset is cross-sectional, presenting a snapshot of diverse enterprises and their chief executive officers at a particular juncture. It encompasses 209 instances and 10 parameters, as indicated by its measurements (209 rows and 10 columns).

These variables encompass a mix of continuous and categorical types. Continuous variables include salary, pcsalary, sales, roe, pcroe, and ros. The categorical ones are indus, finance, consprod, and utility, signifying different attributes of the companies and their CEOs. The salary variable reflects the CEO's salary in thousands of US dollars, while pcsalary indicates the percentage change from the previous year. Sales denote the firm's sales in the preceding year in millions of US dollars. Roe signifies the average return on equity, and pcroe stands for the percentage change in return on equity from the previous year. Ros denotes the average return on the firm's stock. The binary variables indus, finance, consprod, and utility signify the firm's type: industrial, financial, consumer product, or utility.

The summary statistics present a broad overview of the data. Take the salary variable, for instance, which spans from 223 to 14,822. The median stands at 1,039, and the mean is 1,281, pointing to noticeable variability in CEO salaries. There's a range in sales as well, from 175.2 to 97,649.9. The median sales figure is 3,705.2, with a mean of 6,923.8, indicating diversity in firm sizes, from small to large.

The categorical variables offer insights too. Consider the indus variable, reflecting whether a firm is industrial, with a mean of 0.3206, implying that around 32% of firms in the dataset are industrial. Similarly, the finance variable has a mean of 0.2201, signifying approximately 22% of firms being financial. Below is a table summarizing the statistics for each variable in the dataset:

Table 1: statistics for each variable in the dataset

Variable	Min	1st Qu.	Median	Mean	3rd Qu.	Max
salary	223	736	1039	1281	1407	14822
pcsalary	-61	-1	9	13.28	20	212
sales	175.2	2210.3	3705.2	6923.8	7177.0	97649.9
roe	0.5	12.4	15.5	17.18	20.0	56.3
pcroe	-98.9	-21.2	-3.0	10.8	19.5	977.0
ros	-58.0	21.0	52.0	61.8	81.0	418.0
indus	0	0	0	0.3206	1	1
finance	0	0	0	0.2201	0	1
consprod	0	0	0	0.2871	1	1
utility	0	0	0	0.1722	0	1

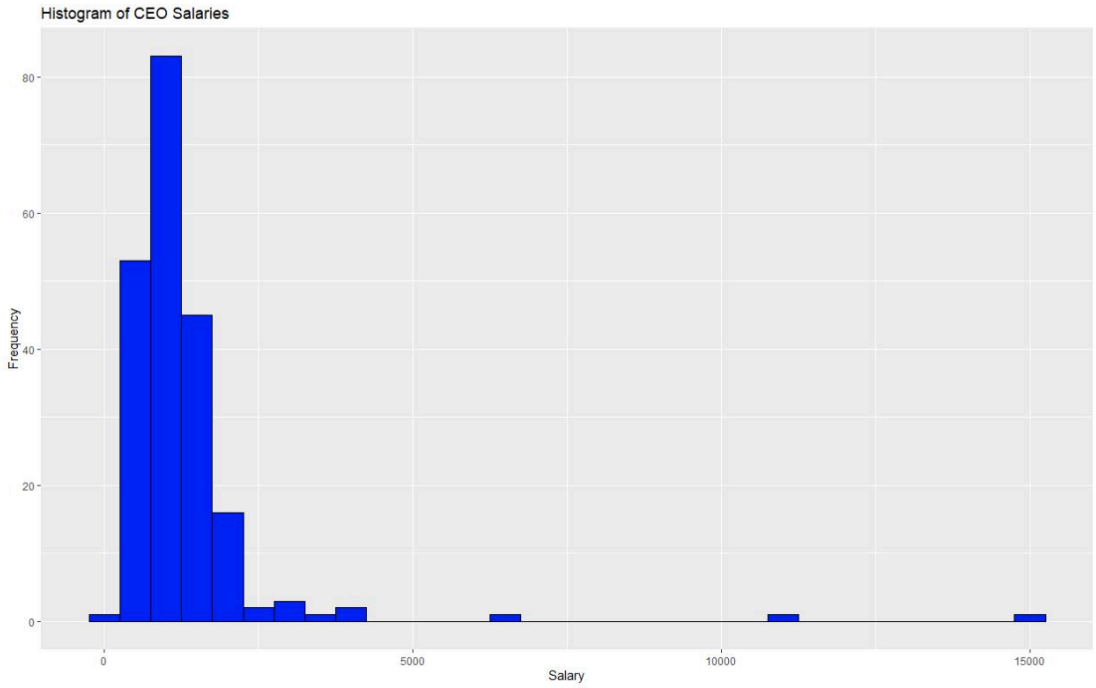

Figure 1: Histogram displaying the distribution of CEO salaries in the dataset

The histogram visually depicts the CEO salary distribution within the dataset. On the x-axis, we find the salary, spanning from 0 to approximately 15,000, while the y-axis denotes the frequency for each salary interval. Notably, a discernible trend emerges, illustrating that a significant proportion of CEO salaries align with the lower echelons, particularly within the range of 0 to about 2,000. This prevalence manifests through the towering bars situated on the left side of the histogram. As one traverses towards higher salary brackets, a corresponding decline in frequency becomes apparent, indicating a diminishing number of CEOs commanding higher remuneration. This attenuation is perceptible in the diminished stature of the bars as we progress towards the histogram's right flank. Infrequent occurrences are observable at elevated salary tiers around 5,000, 10,000, and just preceding 15,000, signaling that only a sparse cadre of CEOs commands these loftier sums. The distribution thus intimates a positive skewness in CEO salaries, typified by an elongated tail on the right. Such skewness aligns with the common pattern observed in salary distributions, wherein a substantial cohort earns relatively modest salaries, juxtaposed against a diminutive faction enjoying markedly elevated compensations.

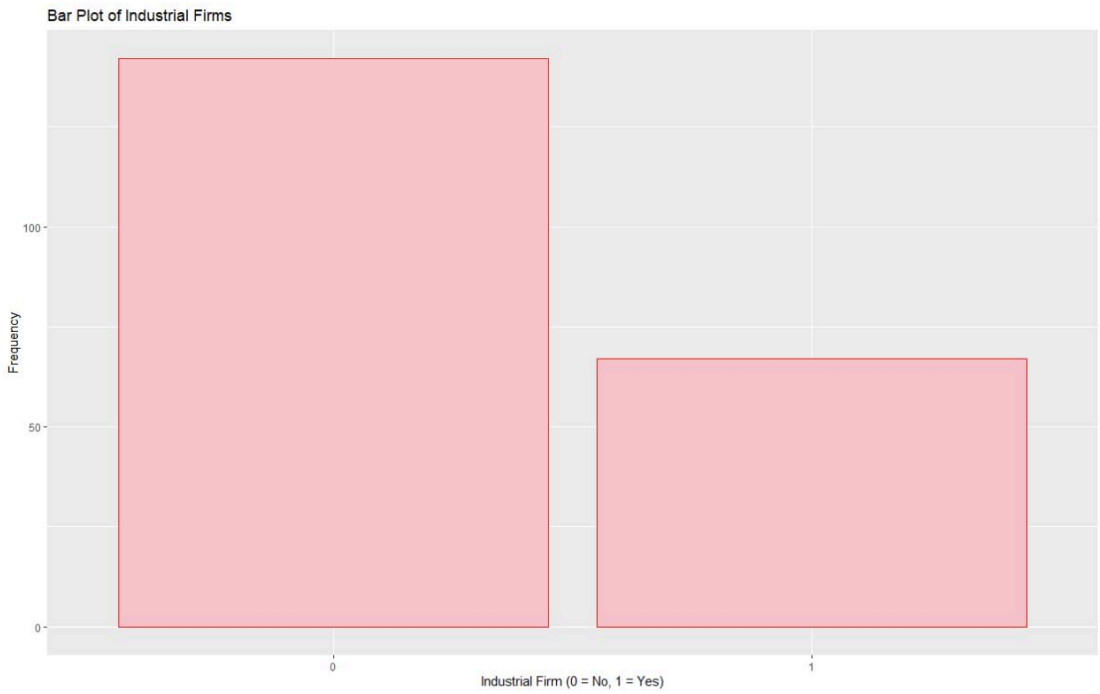

Figure 2: A bar plot showing a visual representation of the distribution of industrial firms in the dataset.

The bar chart visually shows how industrial firms are distributed in the dataset. On the x-axis, 0 stands for non-industrial firms, while 1 stands for industrial firms. The y-axis shows the frequency of each type. It's clear from the chart that most firms in the dataset fall into the non-industrial category (0), seen in the taller bar. In contrast, there are notably fewer industrial firms (1), indicated by the shorter bar. This implies that industrial firms make up a smaller percentage of the total firms in the dataset. This information could be relevant for subsequent analyses, considering that the type of firm might have an impact on variables like CEO salary.

Inferential Analysis

Simple Linear Regression

The study carried out involves a basic linear regression, a statistical technique applied to comprehend and measure the connection between two factors. In this scenario, the CEO's salary (salary) serves as the dependent variable, while the firm's sales (sales) function as the independent variable. The equation representing the model for this analysis can be articulated as follows:

$$salary = \beta_0 + \beta_1 \times sales + \epsilon$$

Where:

- Salary, serving as the dependent variable, signifies the CEO's compensation.
- Sales, functioning as the independent variable, signifies the company's sales performance.
- β0 (beta zero) assumes the role of the y-intercept, indicating the projected salary when sales are zero. In this instance, the estimated value for β0 stands at 1.174e+03 or 1174.
- β1 (beta one) denotes the slope of the regression line, portraying the alteration in salary with each unitary increment in sales. In this specific scenario, the estimated value for β1 stands at 1.547e-02 or 0.01547.
- ϵ (epsilon) serves as the error term, accommodating the unexplained fluctuations in salary not attributable to sales.

The outcomes of the model reveal several crucial insights. Both the intercept and slope coefficients exhibit statistical significance, signifying their deviation from zero. Nevertheless, the p-value pertaining to sales is 0.0838, exceeding the 0.05 threshold, implying that sales might not wield considerable influence as a predictor of salary at the 5% significance level. The R-squared value stands at 0.01437, denoting that a mere 1.4% of the fluctuation in CEO salaries finds explication through sales. This points to the prospect that unaccounted variables, omitted from the model, could serve as pivotal predictors of CEO salary. The residuals, embodying the variance between observed and predicted values of the dependent variable, span from -1463.7 to 13614.6, indicating potential substantial disparities in the model's predictions for specific observations. The F-statistic assesses the overall significance of the model, with the associated p-value reaching 0.08385, surpassing the 0.05 benchmark and hinting at the model's lack of statistical significance at the 5% level.

Multiple Linear Regression

The outcomes displayed stem from a multiple linear regression examination. In this scenario, the CEO's salary, denoted as "salary," functions as the dependent variable. Meanwhile, the independent variables

encompass the firm's sales, labeled as "sales," along with the return on equity, abbreviated as "roe," and the return on the firm's stock, referred to as "ros." The equation depicting the model employed for this analytical pursuit is as follows:

$$salary = \beta_0 + \beta_1 \times sales + \beta_2 \times roe + \beta_3 \times ros + \epsilon$$

where

- The dependent variable, denoted as 'salary,' stands as a representation of the CEO's compensation.
- The independent variables, encompassing 'sales,' 'roe,' and 'ros,' delineate the firm's sales, return on equity, and return on the firm's stock, respectively.
- β0 (beta zero) serves as the y-intercept, portraying the anticipated salary when all independent variables register zero. In this instance, the estimated value for β0 is 864.117516.
- The slopes of the regression line, denoted as β1, β2, and β3, encapsulate the changes in salary corresponding to each unit increase in the respective independent variables. Notably, the estimated values are as follows: β1 - 0.015482, β2 - 22.003312, and β3 - (-1.105191).
- The error term, symbolized by ϵ (epsilon), assumes the role of accounting for the variations in salary unexplained by the independent variables.

The model's outcomes offer several notable insights. The intercept holds statistical significance, implying its deviation from zero. Nevertheless, the p-values for sales, roe, and ros exceed 0.05, hinting at the potential insignificance of these variables as predictors of salary at the 5% significance threshold. The R-squared value, standing at 0.03191, signals that a mere 3.19% of the variability in CEO salaries finds explication through sales, roe, and ros. This points to the likelihood that unaccounted variables outside the model might wield influence on CEO salary predictions. The residuals, reflecting the variance between observed and predicted values, span a range from -1495.0 to 13516.4, suggesting that the model's prognostications could significantly deviate for certain instances.

T-tests

The results provided stems from a statistical analysis known as the Welch Two Sample t-test. This test is employed to ascertain whether the means of two groups exhibit significant differences. In this particular instance, the two groups under consideration are industrial firms denoted by 'indus = 1' and non-industrial firms denoted by 'indus = 0'. The variable of focus in this analysis pertains to the CEO's salary, denoted as 'salary'.

The t-test furnishes key information as follows:

- t-value: 1.368, denoting the difference between group means in standard error units. Positive values indicate the first group's (non-industrial firms) mean exceeds the second group's (industrial firms).

- Degrees of Freedom (df): 196.25, estimating the independent information pieces available for variance estimation.
- p-value: 0.1729, greater than 0.05, implying no statistical significance in mean differences between the groups at the 5% significance level. In essence, insufficient evidence supports the conclusion that CEO average salaries in industrial firms differ from those in non-industrial firms.
- Confidence Interval: The 95% confidence interval for mean differences spans -92.16249 to 509.50409, indicating 95% confidence in the true mean difference residing within this range.
- Sample Estimates: Mean CEO salary for non-industrial firms (group 0) estimated at 1348.014, while for industrial firms (group 1) estimated at 1139.343.

The t-test results suggest that there is no significant difference in the average salaries of CEOs in industrial and non-industrial firms.

Discussion and Conclusions

The core inquiry addressed by this study centered on identifying the primary factors influencing CEO compensations. Employing a sequence of analytical techniques, both descriptive and inferential, we endeavored to elucidate the correlation between CEO salaries and diverse firm attributes such as sales, return on equity, and stock returns.

The findings derived from the straightforward linear regression indicated that sales alone might not serve as a robust predictor of CEO salary. Furthermore, the multiple linear regression model, encompassing sales, return on equity, and stock returns as predictive variables, also indicated that these factors may not wield substantial influence on CEO salary. T-tests carried out to compare the average salaries of CEOs in industrial and non-industrial firms, as well as financial and non-financial firms, proposed an absence of noteworthy distinctions in the average CEO salaries within these categories.

The research indicates that CEO salaries might be affected by various factors beyond just the firm characteristics considered in this analysis. Other elements, potentially related to individual CEO traits or the broader economic and regulatory environment, may also play a role. The implications of these findings are noteworthy. For individuals, especially aspiring CEOs, these results offer insights into potential factors influencing their earnings. Policymakers could use an understanding of CEO salary determinants to shape policies addressing income inequality and advocating for equitable compensation practices. These findings also signal the need for additional research to unravel the intricate dynamics of executive compensation.

In conclusion, though this research has provided insights into CEO salary determinants, the results indicate a complex relationship influenced by numerous factors beyond firm characteristics. This underscores the necessity for a more nuanced understanding of executive compensation, considering the interplay of individual, firm, and environmental factors.

Robustness of the Result

To ascertain the validity and reliability of the linear regression model, tests were conducted to assess the assumptions of homoscedasticity and the absence of autocorrelation. The plot depicting residuals against fitted values exhibited no discernible pattern, implying a consistent variance of errors across independent variable levels. Confirming this, the Breusch-Pagan test yielded a p-value of 0.7441, surpassing the 0.05 threshold, indicating an absence of heteroscedasticity. Consequently, the homoscedasticity assumption remained intact. Given the cross-sectional nature of the data, concerns related to autocorrelation were non-existent. In cases of time series data, the Durbin-Watson test could be applied for autocorrelation assessment. Robust standard errors, computed using the sandwich package in R, offered alternative estimations robust to assumption violations. These robust standard errors exhibited marginal disparities from the original ones, lacking substantial distinctions.

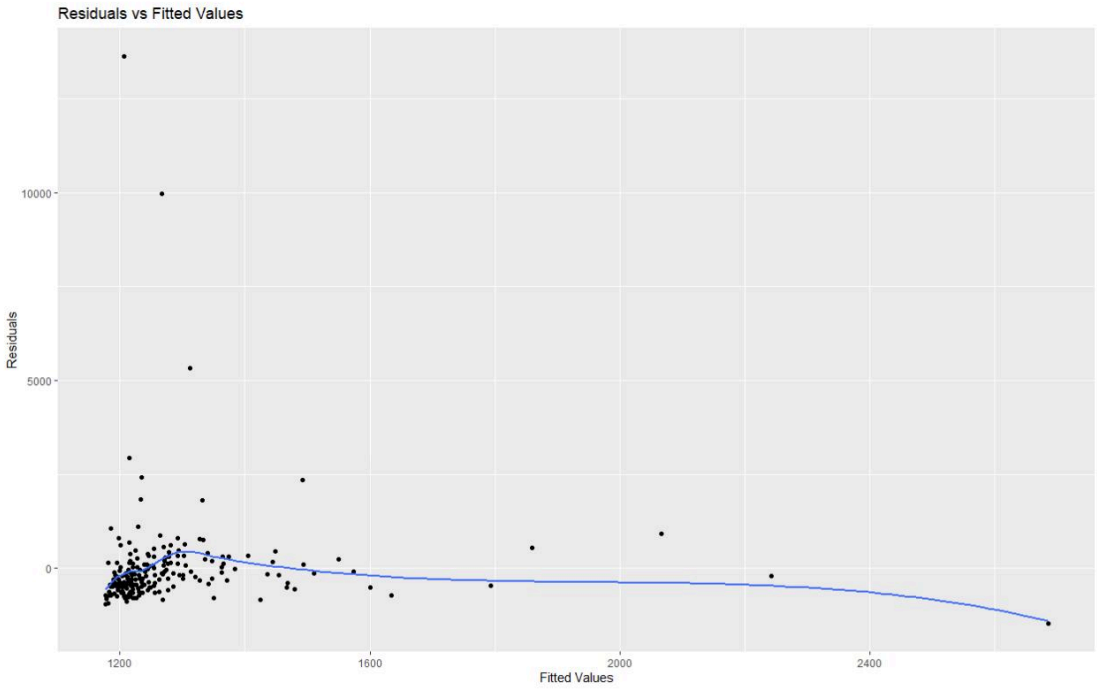

Figure 3: A plot of residuals against fitted values

Consideration of Alternative Functional Forms

The choice of the functional form in the regression model should be guided by both theoretical underpinnings and the attributes of the variables involved. In our investigation, a linear form was employed; however, it is imperative to recognize that this might not invariably represent the optimal fit. Consider a scenario where the relationship between CEO salary and firm sales is not linear but rather exponential. In such instances, opting for a log-linear or semi-log model could potentially offer a more appropriate representation. This decision regarding the functional form holds significance not only for the

interpretation of results but also for the formulation of subsequent policy recommendations. Acknowledging the potential non-linearity in relationships and making informed choices regarding the model's structure is paramount to ensuring robust and meaningful outcomes that can better inform policymaking and strategic decision-making processes.

Relation to the Literature

This investigation contributes to the existing body of knowledge concerning executive compensation—a subject of noteworthy interest within the domains of finance, accounting, and economics. The formulation of research inquiries and the empirical model drew insights from the extant literature, which posits a connection between CEO salaries and diverse firm characteristics. Nevertheless, the outcomes of this study diverge from certain conventional perspectives in the field, presenting a nuanced stance on the determinants of CEO salaries.

Past research endeavors have scrutinized the influence of various factors on CEO compensation. These encompass considerations like political promotion (Cao et al., 2019), non-financial performance metrics (Gan et al., 2020), gender (Harris et al., 2019), narcissism (Lin et al., 2020), and pay disparity (Rouen, 2020). The results of these investigations exhibit a mix of outcomes, with certain factors showcasing positive, negative, or inconsequential impacts on CEO compensation. Additionally, some inquiries have delved into the association between CEO compensation and firm performance, investigating whether alignment or misalignment exists between the two.

This study contributes to the existing body of knowledge by delving into the connection between CEO remuneration and firm attributes, such as sales, return on equity, and return on the company's stock. The outcomes from the linear regression models indicate that these variables might not serve as significant indicators of CEO salary, which contradicts certain findings in the current literature. The outcomes from the t-tests propose that there exists no noteworthy contrast in the mean salaries of CEOs across various categories of firms, be they industrial, financial, or dealing in consumer products.

The findings from this study suggest that CEO compensation is intricately entangled in a multifaceted interplay of various factors, surpassing the confines of the specific firm attributes meticulously examined in this analysis. There exists a plausible nexus with other elements, potentially entwined with the personal characteristics of the CEOs or the broader economic and regulatory milieu, capable of exerting a pivotal influence on executive remuneration. These revelations underscore the inherent complexity shrouding the realm of executive compensation, underscoring the imperative need for additional and thorough investigation. By offering a detailed view on the factors affecting CEO salaries, this study contributes significantly to the ongoing conversation and provides valuable insights with broad implications. The importance is not only in grasping the complex factors influencing CEO compensation but also in recognizing the existing gaps in current knowledge, opening the door for additional exploration. This

nuanced viewpoint serves as a valuable resource for policymakers, practitioners, and fellow researchers, offering insights that transcend the immediate context and contribute to the broader understanding of executive compensation dynamics.

References

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