**Arab American University**
**Faculty of Graduate Studies**
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**Ph.D. Program in Accounting and Finance**

# Towards a Normative CEO Compensation: Mathematical Benchmarking.

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## Declaration

I declare that, expect where explicit reference is made to the contribution of others, this dissertation is substantially my own work and has not been submitted for any other degree at the Arab American University or any other institutions.

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## Dedication

This dissertation is dedicated to the people who have been my greatest strengths and unyielding sources of support throughout the long, arduous journey I have undertaken.

To my advisor: I am the scholar and researcher I am today because of your insight. I was motivated to think beyond my capabilities by your ability to redirect my thoughts and to challenge my preconceptions.

To my family and friends who shared this journey with me, thank you for everything.

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**Towards a Normative CEO Compensation: Mathematical Benchmarking.**

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## Abstract

This research uses solid geometry to develop a helpful and effective mathematical model for quantifying CEO efficiency. The model suggests an index that captures three main dimensions—firm performance, firm size, and CEO compensation—within a three-dimensional space. This allows for the explanation of how executive compensation is linked to business success and the company's size. The model is based on employing advanced mathematics to serve the "informativeness" principle and enabling more accurate comparisons of CEOs within the same business line. The process helps develop more equitable compensation programs by linking pay directly to actual performance and firm size rather than to murky or subjective benchmarks.

The study also empirically tests the model by applying it to the listed companies in the Dow Jones Index from 2019 to 2023. This real-world test assesses the extent to which the model accurately predicts outcomes and whether it functions effectively outside of theoretical frameworks. The results demonstrate that the model successfully identifies variations in CEO efficiency and provides valuable insights into structuring executive pay. Based on these findings, the study recommends expanding the model's application to companies in other industries and markets beyond those in the Dow Jones. This could empower policymakers to enhance their practices in establishing fair executive compensation. Finally, the study encourages other researchers and financial practitioners to investigate how solid geometry can serve as an effective tool for addressing complex financial and measurement challenges, especially where rigorous, multidimensional analysis is necessary.

Keywords: CEO Compensation, Benchmarking CEOs, CEO Efficiency, Solid geometry.

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## List of Definitions of Abbreviations

| Abbreviations | Title |
|---|---|
| CEO | Chief Executive Officer |
| DJIA | Dow Jones Industrial Average |
| EPS | Earnings per Share |
| AAPL.OQ | Apple Inc |
| AMGN.OQ | Amgen Inc |
| AMZN.OQ | Amazon.com Inc |
| AXP.N | American Express Co |
| BA.N | Boeing Co |
| CAT.N | Caterpillar Inc |
| CRM.N | Salesforce Inc |
| CSCO.OQ | Cisco Systems Inc |
| CVX.N | Chevron Corp |
| DIS.N | Walt Disney Co |
| GS.N | Goldman Sachs Group Inc |
| HD.N | Home Depot Inc |
| HON.OQ | Honeywell International Inc |
| IBM.N | International Business Machines Corp |
| JNJ.N | Johnson & Johnson |
| JPM.N | JPMorgan Chase & Co |
| KO.N | Coca-Cola Co |
| MCD.N | McDonald's Corp |
| MMM.N | 3M Co |
| MRK.N | Merck & Co Inc |
| MSFT.OQ | Microsoft Corp |
| NKE.N | Nike Inc |
| NVDA.OQ | NVIDIA Corp |
| PG.N | Procter & Gamble Co |
| SHW.N | Sherwin-Williams Co |
| TRV.N | Travelers Companies Inc |
| UNH.N | UnitedHealth Group Inc |
| V.N | Visa Inc |
| VZ.N | Verizon Communications Inc |
| WMT.N | Walmart Inc |

# 1. Chapter One: Introduction

## 1.1. Background.

The growing concern of policymakers, researchers, and analysts on the issue of chief executive officer (CEO) compensation as one of the critical topics of the agency problem obligates researchers and concerned parties to search for solutions to evaluate the compensation of the CEO by using several methods. Compensation for CEOs is a delicate issue and a controversial topic in corporate governance, which plays a role in solving the agency problem as it helps principals in monitoring expenditures Jensen and Meckling (1976), with critics claiming that overpaid CEOs and so pursue strategies that maximize their profits rather than the benefit of shareholders (Sikawa et al., 2020). This issue has encouraged academics and researchers to investigate CEO compensation's determinants, conditions, components, and constraints of CEO compensation. Previous studies have had several views, as each differs in studying the issue according to its objectives and research circumstances. Mishel and Wolfe (2019) report that the ratio of CEO to worker compensation in the United States increased from 20/1 in 1965 to over 300/1 in 2018. These indicators have sparked debates about pay gaps and how companies are managed. Many critics say that very high CEO pay hurts employee motivation, makes stakeholders lose trust, and reduces public belief that companies are being fair (Bebchuk & Fried, 2004).

The determinants of CEO compensation are multifaceted, encompassing firm size, performance, industry characteristics, and governance structures. While proponents of high executive pay argue that it reflects the competitive market for talent and aligns CEOs' interests with shareholders through performance-linked incentives, critics point to potential agency problems and rent-seeking behavior (Jensen & Meckling, 1976). Benchmarking, a widely used method for setting CEO pay, embodies these tensions as it seeks to align compensation with market norms while avoiding the pitfalls of unjustified escalation.

In contrast, many studies investigate the influence of firm performance and firm size - or value - on CEO compensation; other studies focus on benchmarking CEO compensation and comparing CEO performance with peer firms to arrange CEO compensation. According

to agency theory, if there are no rules or systems to guide them, CEOs might focus on their interests instead of what is best for the company in the long run. This is why comparing CEO pay to what other companies offer is important — it helps attract and keep skilled leaders while ensuring their pay is fair compared to the market. However, when companies try to place their pay packages above the median to recruit above-average talent, Jensen and Murphy (1990) warn that an over-reliance on benchmarking can result in upward spirals in compensation.

On the other hand, Human capital theory emphasizes the role of education, experience, and skills in determining an individual's value in the labor market. From this perspective, benchmarking reflects the premium placed on executives with unique abilities to navigate complex organizational and market environments (Becker, 1964). Nevertheless, according to empirical research, there is frequently no association between CEO remuneration and company performance, raising doubts that high compensation consistently represents superior human capital (Tosi et al., 2000).

Empirical studies provide mixed evidence on the effectiveness and fairness of benchmarking in CEO compensation. For example, Bizjak et al. (2008) find that firms frequently select peer groups strategically, inflating benchmarks to justify higher pay. Similarly, Peer group manipulation frequently leads to compensation packages that are above market standards, as demonstrated by Faulkender and Yang (2010), decreasing the reliability of the benchmarking process. Larcker and Holthausen (1999) explain that these issues can be solved by using good governance practices, such as having independent committees to decide executive pay and giving shareholders more say. Their findings show that strong governance is essential to ensure fair pay comparisons match both company success and what stakeholders need.

Some challenges with comparing CEO pay to other companies include the chance of increasing salaries too much, the difficulty of choosing the right company to compare with, and the risk of losing shareholder trust. Establishing standards based on big, successful organizations, for example, could inflate CEO salaries for smaller or less successful businesses, separating pay from performance (Gabaix & Landier, 2008). Furthermore, an

over-reliance on benchmarking can exacerbate compensation inequality and lower employee morale while maintaining organizational unfairness.

## 1.2. Research Problem.

The problem of the study stems from the urgent need to establish an objective and accurate measurement of the CEO efficiency, in addition to the need to establish a clear and accurate methodology that enables decision-makers to choose the correct benchmark for the executive director objectively in a way that ensures the interaction of the firm's size and performance with the CEO compensation as the most important factors influencing the evaluation of the CEO. Furthermore, there is a need for a robust mathematical model that enables decision-makers to objectively adjust CEO compensation to ensure that compensation is consistent with normative CEO compensation. This problem has been discussed in several theories and referred to by many empirical studies.

Based on the literature, the issue of inappropriate CEO compensation is highly repeated in several theories. As Jensen and Meckling (1976) articulated, agency theory is one of the most influential theories explaining CEO pay. The theory posits an inherent conflict of interest between shareholders (principals) and managers (agents). In order to match the interests of CEOs and shareholders, compensation packages frequently contain performance-based incentives like stock options and bonuses. Critics counter that these incentives may promote risk-taking and short-termism, harming the company's future sustainability (Bebchuk & Fried, 2004). The Managerial Power Theory, explained by Bebchuk and Fried (2004), says CEOs often have much control over their own pay because they can influence the company’s board. This sometimes leads to rent extraction, meaning CEOs are compensated much more than they deserve based on their performance or the value they generate to the company. The theory also points out that when corporate governance is weak, it becomes easier for CEOs to set high pay for themselves.

Another idea generates from Tournament Theory, introduced by Lazear and Rosen (1981). This theory says that high CEO pay motivates lower-level managers to work harder and compete for top jobs, which helps boost overall effort and productivity. Critics note that

this approach may increase inequality in companies and ignore the dynamics of the external labor market.

According to the social comparison theory, which is another perspective on the subject, CEOs define their compensation in relation to those of their peers in companies or industries, which causes compensation levels to rise. O'Reilly and Main (2010) claim that compensation consultants and a societal focus on power and status are the main drivers of this dynamic. On the other hand, empirical evidence proves the issue. Aguinis et al. (2018) assert that only a few executives attain fair compensation and discovered that a small percentage of the highest-paid CEOs were among the CEOs who performed the best. These findings raise concerns about distributive justice and provide little evidence to support the efficient contracting hypothesis of agency theory. Hayward and Hambrick (1997) argue that if overpayment is defined as compensation above performance, then executive hubris may be one of the causes. In this scenario, the executive might be qualified to create and implement a suitable strategy for the company. However, a conceited CEO might utilize extremely dangerous tactics or "set the goals too high" due to overconfidence. Moreover, Haynes et al. (2017) found that executive greed negatively affects shareholder returns. Wang and Murnighan (2011) suggested that managers could extract excessive personal returns by taking extraordinary risks born by their firms because of how the incentive compensation systems were structured. In these cases, the managers extracted significant returns from the firm for their gain, producing weaker firm performance (Bebchuk et al., 2010). The research problem comes from the issue of unfair CEO pay. It would be helpful to create a straightforward way to evaluate CEO compensation, check how well the CEO performs, and compare their performance with CEOs at peer companies.

### 1.3. Motivation and Importance.

This study is important because a precise method is needed to help decision-makers control the rise in executive pay. This method offers a useful tool to improve corporate governance and address the conflict between executives and shareholders. In addition, Greekforgeek published an article in 2023 that explains how geometry and other math concepts are used in business and management. The article shows why math skills, like understanding geometry, are important for solving real business problems, such as dealing

with measurement errors. Specifically, geometry is used in determining the most efficient arrangement of goods in warehouses, optimizing the utilization of storage spaces, and calculating volumes and areas for product packaging. These techniques also help reduce costs and improve operational efficiency by minimizing wasted space or materials (GeeksforGeeks, 2023). However, this research is the first attempt to employ solid geometry functions to resolve the controversy regarding the judgment of the director's compensation. It also highlights solid geometry techniques as a measurement approach contributing to financial and accounting knowledge. In addition, a set of models treats the issue of benchmarking CEO compensation. The study provides a hybrid model, merging the melanism of these models, as will be discussed in the literature review chapter.

Furthermore, empirical studies focusing on CEO compensation have generally and consistently, with the theory, found a positive relationship between firm performance and CEO compensation. However, Certain studies pay attention to anomalies in this relationship, such as possible negative associations in particular circumstances. Nourayi (2006) looked at the association between CEO pay and company success and discovered asymmetry and non-linearity; the study suggests that the relationship is complex and may vary depending on performance measures and other factors. Miller (2012) discovered that the influence of firm performance on CEO compensation diminishes as CEO tenure increases. According to this research, CEOs with more experience might be paid less concerning the company's success, which could result in circumstances where pay is out of line with performance indicators. The long-term effects of CEO compensation schemes on pay-for-luck and asymmetry were examined by Ning et al. (2024), who noted that shifts in compensation systems over time may impact how well pay and performance align. This study sheds light on how compensation design may impact the pay-performance relationship, even if it is not explicitly related to the DJIA.

However, this study provides a new step towards solving the unresolved controversial issue of CEO pay in the DJIA. Moreover, it provides a significant method for other markets worldwide.

## 1.4. Research Questions.

The study explores whether presenting the main factors of CEO efficiency in a three-dimensional space has financial significance and correlates with CEO efficiency. This wonder generates the following main questions.

- Is the angle measurement between the vector (which results from the intersection point of (size, performance, and compensation in three-dimensional space) and the performance axis considered an index to express CEO efficiency?

  However, answering the main question facilitates the process of adjusting the actual CEO compensation to the desired compensation and will generate the following sub-question:
- Does the desired CEO compensation generated by the derived equation in this study have a more appropriate value than the actual compensation?

To answer this question, the study builds two models. It compares them, both seeking to explain CEO compensation by its explanatory factors to determine whether the actual or desired compensation generated by the mathematical equation is more related to the explanatory factors. Thus, the main previous question should be divided into two parts:

a. Which compensation is best explained by firm performance, desired, or actual compensation?
b. Which compensation is best explained by firm size, desired, or actual compensation?

## 1.5. Research Objectives.

The objective is to employ solid geometry concepts to create a mathematical formula that provides a thorough and rational foundation for benchmarking CEOs. This equation combines theoretical ideas with real-world applications by linking firm performance and size to CEO compensation, the two most important elements in the literature to date. Additionally, the study aims to assess the validity of the derived CEO efficiency index and provide information on its usefulness. The formula creates a CEO efficiency index that compares CEOs to their peers to determine how well they perform consistently with CEO compensation determinants.

Specifically, the study aims to confirm that laying out the main factors of CEO efficiency in a three-dimensional space has a financial meaning and expresses CEO efficiency. Which needs to achieve the following objectives:

- Proving that the angle measurement between the vector (which results from the intersection point of (size, performance, and compensation in three-dimensional space) and the performance axis is considered an index to express CEO efficiency.
- Proving that the desired CEO compensation generated by the derived equation in this study has a more appropriate value than the actual compensation. This objective is separated into two sub-objectives:
    1. Proving that the firm performance significantly explains the adjusted CEO compensation derived from the mathematical equation.
    2. Proving that the firm size significantly explains the adjusted CEO compensation derived from the mathematical equation.

This method provides a clear formula for evaluating the CEO's contributions to the company's success in the context of equitable measurement, by adjusting the variables that affect CEO compensation to more closely align with pay scales. These adjustments help ensure that the results are more accurate and reflect real-world patterns, leading to a better understanding of what drives CEO compensation.

### 1.6. Procedural Definitions.

- CEO compensation: the total compensation given to the CEO of a company, including both monetary and non-monetary benefits intended to match the CEO's motivations with the objectives of the company and the interests of shareholders. Typically, this package includes base pay, yearly incentives, equity compensation, benefits, and perquisites (Jensen & Murphy, 1990).
- Benchmarking CEO compensation: a methodical approach to comparing the pay and benefits that a CEO achieves with peers in similar roles at comparable companies, ensuring equity, competitiveness, and conformity to market standards (Murphy, 1999).
- Efficient CEO: the CEO who can exploit the minimum economic resources to generate higher economic benefits and, in turn, receives lower total compensation. This assumption is consistent with Oberholzer (2016).

- Firm performance: the ability of a firm to achieve its goals and objectives, encompassing both financial and non-financial dimensions. It is often assessed through metrics such as profitability, revenue growth, market share, customer satisfaction, and operational efficiency (Venkatraman & Ramanujam, 1986).
- Firm size: the quantifiable characteristics that are used to group companies according to the size of their operations. The number of employees, yearly income, total assets, or market share are examples of common indicators (Penrose, 1959).
- Solid Geometry: a branch of mathematics concerned with studying three-dimensional figures, including their properties, measurements, and relationships, applying geometric and algebraic methods to analyze properties, and employing mathematical models (e.g., equations, coordinate systems) to represent solids in 3D space (Hilbert, 1971).
- Mathematical benchmarking: The researcher defines it procedurally as a mathematical tool that uses solid geometry to study the relationships and interactions between executive compensation and its explanatory factors in a three-dimensional space, ensuring the generation of an indicator of the executive's efficiency.

# 2. Chapter Two: Literature Review

## 2.1. Introduction

CEO pay is an important part of how companies are managed and how they plan their strategies. It shows the connection between the rewards given to top executives, how well the company performs, how big the company is, and what stakeholders expect. Different theories have been created to explain how CEO pay is set, what factors affect it, and what it means for companies. This section discusses the main ideas behind executive pay, including positive and normative theories, agency theory, managerial power theory, tournament theory, and social comparison theory. Each of these provides a different, but related, way to understand how CEO pay is decided — whether based on market forces, ethical concerns, or good governance practices.

This section also discusses how companies compare CEO pay to performance, firm size, and what other companies in the same industry pay. A new part of this study adds solid geometry as a tool to measure how efficiently CEOs are paid. This offers a 3D method to analyze pay structures. By combining traditional theories with this new geometric approach, the goal is to give a full picture of how CEO pay connects to company performance and other factors.

## 2.2. Theoretical Framework.

### 2.2.1. Normative Vs. Positive Compensation

CEO compensation remains one of the most debated topics in corporate governance, with discussions centered around how executive pay is determined (positive approach) versus how it should be structured (normative approach). The positive approach to CEO compensation focuses on empirical observation, economic incentives, and market forces, explaining why executives are paid what they are based on firm performance, labor market competition, and incentive structures (Jensen & Murphy, 1990). On the other hand, the normative approach, which supports CEO pay structures that advance equity, reduce inequality in income, and match CEO compensation with social welfare considerations, is prescriptive and moral (Bebchuk & Fried, 2004). While the positive theory explains the current state of executive compensation, the normative theory questions whether it is ethically, economically, and socially justifiable.

### 2.2.2. Positive CEO Compensation: Market-Driven and Performance-Based

The positive perspective on CEO compensation is rooted in economic and behavioral theories, primarily agency, human capital, and tournament theories (Murphy, 2013). According to agency theory, introduced by Jensen and Meckling (1976), CEO pay must be structured to align executive incentives with shareholder interests. In order to minimize agency conflicts and guarantee that executives endeavor to maximize shareholder value, compensation packages usually incorporate performance-based incentives, including stock options, bonuses, and long-term equity compensation. Studies have shown that higher performance-linked compensation structures correlate with better firm outcomes, supporting that market-driven executive pay effectively motivates CEOs to deliver financial success (Edmans & Gabaix, 2016).

Furthermore, human capital theory (Becker, 1964) argues that CEO compensation reflects the talent, skills, and experience necessary to lead large corporations. Firms compete for the best executive talent, which drives up CEO pay based on supply and demand dynamics. Gabaix and Landier (2008) Show that CEO compensation increases exponentially with firm size to support this theory; It suggests that larger companies need to pay much greater compensation to attract top talent. Furthermore, according to tournament theory of Lazear and Rosen (1981), CEO remuneration is based on a hierarchical reward structure, offering incentives for improved performance and productivity due to the wide gap in wages between CEOs and lower-level management. Empirical evidence supports that firms with more extensive CEO-to-employee pay differentials experience increased competitiveness and efficiency (Bognanno, 2001).

#### 2.2.2.1. Normative CEO Compensation: Ethical and Fair Pay Considerations

In contrast to the positive approach, the normative approach to CEO compensation is grounded in ethics, corporate social responsibility (CSR), stakeholder theory, and distributive justice principles. Advocates of normative compensation structures argue that CEO pay should be determined by what is fair and just rather than purely market-driven factors (Bebchuk & Fried, 2004). High CEO compensation causes inequality in income and threatens societal unity, and employee morale is one of the main concerns. Freeman's stakeholder

theory (1984) states that executives have obligations to society, customers, employees, and shareholders. Hence, CEO pay should reflect financial performance and contributions to long-term sustainability and social impact (Donaldson & Preston, 1995).

A critical aspect of normative compensation theory is distributive justice, as proposed by Rawls (1971), who argues that economic inequalities should be structured to benefit the least advantaged members of society. Excessive CEO compensation, particularly when companies underperform or lay off workers, is perceived as unjust and misaligned with corporate ethical responsibilities (Piketty & Saez, 2014). Some scholars argue that CEO pay ratios should be capped in countries where executive compensation is regulated to ensure fairness (Neumark & Wascher, 2008). Additionally, to ensure that remuneration reflects the entire satisfaction of the company rather than favoring a small group of individuals, living wage principles advise businesses to create a more equitable pay distribution between executives and employees (Dube, 2019).

The conflict between market efficiency and ethical responsibility is shown by looking at different approaches to CEO compensation. The positive approach defends high CEO pay by linking it to performance, competition, and the size of the company, suggesting that pay should motivate executives to act in the best interest of shareholders (Murphy, 2013). Conversely, to ensure that CEO compensation considers social and ethical factors beyond profit maximization, the normative view proposes that pay structures should support fairness, corporate accountability, and economic equality (Bebchuk & Fried, 2004). Although both models give insightful information, the greatest long-term option for corporate governance and sustainable economic growth may be a hybrid strategy that balances ethical compensation structures and market efficiency.

CEO compensation is essential to corporate governance and organizational planning because it reflects the relationship between executive incentives, business performance, and shareholder interests. Over the years, several theoretical frameworks have been established to explain the factors that impact CEO pay structures and their effects. For example, Managerial power theory examines how executive authority affects compensation design,

while agency theory emphasizes how executive actions relate to shareholder interests. These perspectives offer ways to look at the complexity of CEO compensation.

Additionally, Social comparison theory looks at how peer salaries affect pay decisions, while tournament theory focuses on how pay differences between levels encourage better performance. Comparing CEO pay to company size and performance helps show how pay structures align with the goals of the organization. Together, these theories offer a sophisticated knowledge of how more extensive organizational and market variables both influence and are influenced by CEO remuneration, which is helpful information for stakeholders, boards, and policymakers.

### 2.2.3. Agency Theory:

Agency theory, which was initially developed by Jensen and Meckling (1976), provides a simple model for analyzing CEO compensation structures, particularly for matching managerial incentives to shareholder interests. Agency theory is characterized by an underlying conflict between principals (shareholders) and agents (executives) as their interests may not be the same in all circumstances. Shareholders seek to increase firm value and CEOs may seek to personal objectives. Agency issues may arise when CEOs prefer their own interests over increasing shareholder value. In order to lessen these conflicts and align incentives, pay structures are a crucial governance tool. A moral hazard occurs when CEOs have substantial decision-making authority but do not fully face the implications of their choices. This is known as the principal-agent problem. Compensation mechanisms such as stock options, performance-based bonuses, and long-term equity ownership are designed to encourage executives to act in the best interests of shareholders while reducing agency costs. According to Eisenhardt (1989), agency costs, which include expenses related to monitoring, bonding, and residual losses, highlight the inefficiencies in the relationship between shareholders and executives. Monitoring costs arise when shareholders implement oversight mechanisms such as corporate governance structures, while bonding costs occur when executives take actions to assure shareholders of their commitment. On the other hand, residual losses stand for the inefficiencies that continue regardless of governance measures, highlighting the necessity of carefully thought-out pay plans to balance the interests of management and shareholders successfully.

Fama and Jensen (1983) argue that incentive-based compensation models mitigate agency conflicts by directly linking CEO wealth to firm performance. By linking CEO pay to performance, companies can encourage executives to focus on creating long-term value instead of seeking short-term personal gains. Long-term equity plans, restricted shares, and stock options help ensure that executives' decisions align with the goals of shareholders and reduce self-serving actions. Murphy (1999), for example, emphasizes the value of equity-based incentives in keeping CEOs motivated for the company's long-term performance and growth. Performance-based compensation guarantees executives share the risks and rewards related to their strategic choices, in contrast to fixed incomes, which might cause complacency or extreme risk aversion. In order to create incentive schemes that effectively balance risk-taking behavior with motivation, board monitoring and compensation committees are also essential. A properly balanced compensation plan avoids excessive risk-taking that could harm shareholders while guaranteeing that executives receive fair compensation for their contributions to the company's success.

However, traditional agency models have been criticized, particularly regarding the complexities of risk and reward in CEO compensation. Bebchuk and Fried (2004) argue that many traditional compensation models fail to account for executives' risks, particularly firm-specific ones beyond their control. While incentive-based pay can drive performance, it can lead to unintended consequences, such as excessive risk aversion or opportunistic behaviors like earnings manipulation. For example, a CEO may emphasize share buybacks or aggressive accounting techniques to artificially enhance stock prices at the expense of long-term stability if their compensation is unfairly dependent on short-term stock success. Holmstrom and Milgrom (1991) suggest diversification within compensation systems to solve these problems. Businesses can develop a more robust incentive model that motivates CEOs to take measured risks while preserving long-term strategic focus by implementing a diversified approach to remuneration. According to agency theory, executives are hired to manage the company on behalf of shareholders, meaning their actions should be aligned with the owners' interests rather than personal gain (Milkovich & Newman, 1999). Therefore, the design of CEO compensation packages should be sufficiently robust to counteract managerial self-interest while ensuring a sustained focus on firm profitability and value creation. Conyon et al. (1995) and Milkovich and Newman (1999) emphasize that effective compensation

packages must balance offering competitive remuneration and incentivizing executives to drive firm success. Compensation structures should reward top management for measurable accomplishments that reflect shareholder value, such as revenue growth, market expansion, and operational efficiency (Gomez-Mejia & Balkin, 1992). Moreover, governance mechanisms, such as independent compensation committees and shareholder say-on-pay policies, are crucial in maintaining fair and transparent executive pay structures. These governance tools ensure that CEO compensation depends on performance-driven and consistent with the objectives of the company by lowering the likelihood of conflicts of interest between executives and shareholders.

Thus, the need for well-designed incentives that balance the interests of executives and shareholders is highlighted by agency theory, which provides a strong and generally recognized framework for examining CEO compensation. Organizations can successfully handle agency issues and improve performance by implementing robust governance systems, risk and reward balancing, and performance-based incentives. In order to guarantee that leaders stay focused on long-term value creation rather than temporary financial manipulation, a thorough strategy to CEO compensation should consider both short-term and long-term incentives.

### 2.2.4. Managerial Power Theory:

Managerial power theory offers a basic framework to understand the impact of the CEO's power on corporate governance and decision-making. Managerial power theory argues that managers are bestowed with great power because of their position in the organizational hierarchy which can impact governance strategies and shareholder value. The main contention of this theory is that managerial power derives from multiple sources, such as formal powers and control over networks, company resources, expertise, and charisma. According to Finkelstein (1992), these various sources of power influence key decisions, negotiate good terms, and manage stakeholders, such as board members, employees, and investors, respectively. Such power can drive strategic innovation, sound decision-making, and greater organizational effectiveness for business goals. CEOs also use their power to protect their offices, which can result in power imbalances and selfish behavior that would not necessarily be in shareholders' interests. This brings into focus the importance of putting

in place open accountability processes to ensure that power of management is exercised within ethical and strategically appropriate boundaries.

The managerial power theory's function in corporate governance is argued to have significant implications. The theory demands governance structures institutionalizing openness, scrutiny, and protection for shareholders while striking a balance between managerial power. The rationale behind corporate governance mechanisms like independent boards, shareholder voting rights, and adhering to regulations is to balance the power of CEOs and avoid possible conflicts of interest. Dalton et al. (1998) argue that outside directors on the board are a necessary counterbalance to managerial power imbalances, such that executive decisions are made with consideration for shareholder value. Independent board members are more qualified to offer unbiased supervision, evaluate corporate strategy critically, and make decisions that represent the company's larger interests because management does not influence them. Moreover, transparency disclosure and reporting obligations limit managerial freedom of action by making executive actions transparent to regulators and investors. Without such governance, powerful CEOs might put their interests ahead of firm prosperity at the expense of inefficiencies, investor loss of confidence, and governance failure. Effective corporate governance mechanisms, by extension, serve to countercheck executive abuse and promote responsibility and good business conduct.

In the case of CEO compensation, Managerial Power Theory is one of its most important applications. Compensation structures are one of the most critical areas for the application of management power, and they tend to influence the setting of pay levels, bonuses, and equity incentives. Bebchuk and Fried (2004) advance an argument that influential executives can use their power to negotiate for compensation packages that are not necessarily tied to their effort or the health of the company's finances. Even if the company's performance does not justify such rewards, CEOs and other top executives with considerable influence over boards can negotiate large salaries and lucrative stock options. This phenomenon, known as rent extraction, occurs where the managers control boards or compensation committees to extract pay at shareholders' cost for higher personal returns. Further, manager power can structure performance-based incentive design for managers' advantage by setting inconsequential performance targets, awarding backdated stock options,

or offering golden parachutes paying substantial financial rewards independent of firm success. These steps are indicative of the dangers of uncontrolled managerial power and appeal for robust governance structures that balance CEO pay with long-term business goals rather than personal wealth. Organizations must implement policies that enhance oversight, bring fair pay practices under tougher scrutiny, and promote accountability to balance out the threats of uncontrolled managerial power. Some markets have regulatory guidelines to curb executive abuse and encourage transparency, like compulsory shareholder voting on executive compensation and disclosure requirements for compensation packages.

Furthermore, compensation committees chaired by independent directors ensure that compensation levels are determined on the basis of performance and not managerial control. Institutional investors and activist shareholders are also a part of maintaining executives in line, as they can compel the board to follow fair governance and compensation practices. Finkelstein (1992) emphasizes that while managerial power is a natural part of leadership, it must be kept within a system of checks and balances to prevent abuse. Firms can harness management power constructively while reducing the risk of executive abuse by fostering a culture of moral leadership, corporate accountability, and stakeholder involvement. The managerial power theory offers a critical view of CEOs' control of corporate governance, decision-making, and compensation policies. While powers of management may propel organizational efficiency and strategic achievement, it is also risky because it involves potential self-interest, overpayment, and erosion of shareholder rights.

The theory points to the importance of corporate governance mechanisms that offset managerial power with transparency, accountability, and ethical decision-making. Bebchuk and Fried (2004) argued that there should be proper supervisory mechanisms to tie executive incentives with long-term firm performance since unchecked management power in executive compensation may create biases that erode shareholder value. Firms can reduce the risks of managerial opportunism and guarantee an equitable, performance-based work environment by developing efficient governance practices, encouraging independent board monitoring, and encouraging transparency in executive compensation practices.

### 2.2.5. Tournament Theory

Lazear and Rosen (1981) developed the theory of tournaments as a theoretical framework for organizational pay hierarchies based largely on competitive payoffs. The conceptual basis is that, in differentials of pay as the main reward vehicle, workers have incentives to provide more effort and be better when competing for organization levels. Unlike the traditional compensation models, in which wages are explicitly linked to personal productivity, tournament theory regards career advancement as a tournament in which employees compete to surpass each other rather than reaching a certain level of performance. Here, in this setup, promotions are "tournaments," whereby employees vie for a few higher-level positions, and the winning individuals receive much higher compensation and benefits. This competitive structure raises effort and productivity at every level of the organization, producing a competitive climate in which rewards are tied to performance. But Compensation schemes have to be designed with care to balance justice and motivation to avoid pay gaps becoming too high or wasteful.

In accordance with Lazear and Rosen (1981), payment gap size between hierarchy levels is critical in maintaining staff motivation. Additional payment in the form of compensation encourages employees to labor more intensively because the offer for career development is greater than the added effort. The promise of advancement to high-position executive positions, which offer considerably higher compensation and benefits, motivates lower-level workers and increases productivity throughout the company hierarchy. Excessive pay differences, however, could have negative side effects like risky behavior, dishonesty, or discontent at work. Workers can use underhanded methods, like criticizing fellow workers, or put personal interests ahead of company interests if they believe the pay scale does not cut it or is unrealistic. Equitable compensation must, however, be balanced with competitive incentives. This balance must be maintained so that tournament theory can function, keeping employees in a position to view the competition as fair and real and avoiding errors that influence moral behavior. When explaining CEO compensation schemes, the essence of tournament theory matters. At the top of the corporate hierarchy stand the CEOs, whose compensation packages routinely overwhelm those of subordinated executives, and reflect the stupendous rewards of "winning the tournament." The hypothesis maintains that large

money awards at the pinnacle of a company prompt better performance by hopeful executives and encouragement to seek promotion.

This significant pay gap supports that contention. This empirical evidence manifests in the form of Conyon and He (2011), which shows that firms with larger pay gaps between CEOs and other executives tend to have better organizational performance. Organizations motivate executives at each level to promote growth, effectiveness, and strategic success by designing compensation as a tournament reward. But although the theory explains the rationale for sizeable CEO pay disparities, it also raises questions about the broader implications of excessive executive compensation. While big salaries and bonuses can hold top executives and maintain a competitive advantage, they also make companies more unequal in terms of wealth and cause shareholders to become dissatisfied if perceived as disproportionate to company performance. The other core issue of tournament theory is determining adequate CEO compensation. While high monetary pay can be a powerful incentive device, uncontrolled increases in compensation can generate governance and agency issues.

Bebchuk and Fried (2004) indicate that high CEO compensation may occur where managers can influence the compensation committee to pay remuneration above performance warrant. The difficulty in determining proper CEO compensation is also a central point of consideration under the tournament theory. Large cash payments are very powerful incentives, but unbridled pay escalation can create agency and governance concerns. Moreover, tournament theory cannot fully account for external determinants affecting compensation dynamics, such as the state of the economy, industry limitations, or firm-specific risk, although tournament theory accounts for pay differences as a motivational tool. By the integration of governance best practice and use of concepts of tournament theory, organizations can craft compensation schemes that are motivational but equitable and transparent. Lastly, especially for CEO compensation, tournament theory is a handy prism with which to examine hierarchical reward schemes. In a bid to connect personal efforts to company objectives, companies create incentive schemes that craft remuneration as a competitive "prize." However, its successful application calls for scrutiny to ensure it does not create enormous pay gaps that can spawn unintended ethics and governance concerns.

The theory highlights the advantages of competitive incentives. It also highlights the role of balanced pay structures so that compensation policies drive strategic performance and productivity without sacrificing equity and business integrity. By integrating tournament-based incentives with governance safeguards, businesses can utilize hierarchical compensation structures to produce employee motivation and long-term business success.

### 2.2.6. Social Comparison Theory:

According to the Social Comparison Theory, proposed by Festinger (1954), people compare their belief and capability to others, especially where objective standards are unclear or non-existent. CEO pay is a discretionary choice rather than performance-based; the theory has wide application to organizational behavior. Social comparison affects business expectations, satisfaction, and motivation by affecting executives' perceptions of pay relative to others' pay. Applied to CEOs' remuneration, the theory suggests that executives and board members rely on peer benchmarking in determining remuneration levels consistent with industry practice and a firm's competitive standing. Having no clear idea of "fair" remuneration, firms resort to using comparable companies' compensation schemes so that their executives are not underpaid or worse off than their peers. Industry compensation levels are influenced by this benchmarking process that induces social comparison behaviors in CEO compensation choices. In executive compensation, social comparison theory suggests that CEOs and corporate boards compare compensation packages with industry counterparts to decide on perceived fairness and competitiveness (O'Reilly & Main, 2010).

This practice has two motivations: first, companies want to recruit and retain superior managers and industry-normal pay. Second, companies enhance their market standing and corporate equality by employing CEO compensation as a signaling device. Peer benchmarking reports, such as industry surveys and compensation consulting research, have contributed to this trend further, inter-firm comparisons becoming part of executive compensation decisions (Faulkender & Yang, 2013). As much as the motivation behind comparisons is to keep executives motivated and maintain equity, they also help to fuel the phenomena of increasing CEO compensation. Since companies always attempt to match or exceed the compensation offered by competitors, a self-reinforcing loop is formed where CEO pay increases consistently, often exceeding company performance and overall

economic conditions. But one of the major criticisms of social comparison theory in compensation situations is reflected in this growing trend among CEO compensation: Comparisons can make fairness and competitiveness better, but also can skew pay arrangements by focusing on relative position at the expense of current performance results. The interplay between social comparison and equity and power in CEO compensation is one of its most important psychological consequences. CEOs tend to see their pay as a reflection of their status and influence in the corporation and industry (Wade et al., 1997); greater compensation brings parity and economic influence as well as a reflection of professional success.

By prioritizing compensation's symbolic and psychological value, boards of directors might be under pressure to maintain pace with or exceed peer levels of compensation in a bid to keep CEOs content and prevent executive turnover (Main et al., 1995). Such high-pressure situations leave boards in a position to keep driving compensation higher, or else face disengagement or executive flight to other companies providing better compensation. But a skewed pay scale, in which salaries rise irrespective of the performance of a company, can be the outcome of over-reliance on social comparison and peer benchmarking (Bebchuk & Fried, 2004). The impact is particularly significant in those industries with high CEO discretion, where companies are compelled to provide ever-rising incentives to keep the best talent. This creates an inflationary pressure in CEO pay, increasing the differential between executive and general employee compensation and stoking controversy over the ethics of corporate governance and income inequality. In addition, peer benchmarking and internal firm dynamics are extremely social comparison oriented. Concepts of fairness, organizational morale, and productivity are all impacted by the relative differential compensation among CEOs and other upper-level executives and between executives and line employees. When differentials get out of hand, sub-executives begin to perceive themselves as being underpaid, which discourages motivation and invites turnover.

Bloom (1999) asserts that large disparities in compensation levels among companies may prompt feelings of inequity, which will manifest negatively through lost job satisfaction and damaged team cohesion. Employee motivation and loyalty will decline if the employees feel their CEO's income is disproportionately large compared to what they are making,

ultimately being reflected in lower organizational performance. In order to not erode organizational trust or morale through pay structures, boards of directors must trade off internal fairness and external competitiveness. This includes scrutinizing closely compensation policies based on industry practices and internal pay equity to sustain a motivated and engaged workforce. Finally, social comparison theory is a model to explain the determinants of and implications for CEO compensation decisions. It shows how subjective comparisons affect objective pay and displays the double impact of internal pay equity and external benchmarking. Besides helping companies maintain competitive pay structures, social comparison may induce wage inflation and rising earnings inequality within firms.

To face such risks, boards must adopt balanced performance-based and reasonable consideration-based remuneration schemes for CEOs. Executive remuneration schemes can be sustained relative to long-term commercial goals by adopting good systems of governance in the form of independent remuneration committees and transparent remuneration disclosure regimes that can possibly keep peer benchmarking dependence at bay. Firms can design compensation schemes that motivate CEOs without compromising their congruence and fairness by fusing the constituents of social comparison theory with best practices in good governance.

### 2.2.7. CEO Efficiency

Assessing the effect of management on organizational performance requires measuring the efficiency of the CEO. Because executive positions are complex, many approaches have been developed to assess CEO efficiency. Financial performance metrics, which gauge a CEO's ability to increase shareholder value and guarantee company profitability, are the subject of one of the most popular strategies. Return on equity, return on assets, and stock price performance are important financial metrics that show how well a CEO uses business resources to produce returns for investors. (Jensen & Meckling, 1976). Shareholders, analysts, and corporate boards frequently utilize these indicators to judge executive performance since they objectively evaluate the company's financial health. However, financial measures might not accurately capture the influence of a CEO since they frequently

ignore long-term strategic objectives, corporate culture, and stakeholder relationships that support long-term performance.

Non-financial performance measurements evaluate the executive's impact on organizational culture, employee engagement, and innovation, offering a more comprehensive view of CEO efficiency. Research and development output, customer satisfaction scores, and staff satisfaction are all important indicators of a CEO's ability to create a productive and long-lasting business environment (Kaplan & Norton, 1996). Since companies that emphasize innovation and employee well-being tend to do better over the long run, these qualitative metrics are crucial for CEO evaluations. The balanced scorecard integrates both financial and non-financial measurements to quantify CEO efficiency. Balanced scorecards present a view of CEO performance in terms of emphasis on short-run financial returns as well as strategic long-run objectives. This allows earnings to no longer be solely utilized to determine leadership success. While non-financial measurements bring rich data about the influence of leadership, they are subject to being subjective and difficult to measure, requiring powerful data collection and analysis frameworks.

Corporate governance metrics are another crucial tool for assessing CEO efficiency and are especially important for guaranteeing moral leadership and transparency. Assessing whether a CEO keeps high corporate integrity and accountability is made simpler by board assessments, shareholder activism, and governance compliance measurements (Gompers et al., 2003). These metrics are crucial for assessing how well a CEO manages company crises, navigates regulatory settings, and builds investor trust. A CEO prioritizes effective governance procedures is more likely to increase long-term shareholder value and reduce the risk of unethical behavior or bad decisions. Because investors actively engage with corporate leadership to advocate for strategic changes, money management, and social responsibility programs, shareholder pressure is crucial for assessing CEO accountability. However, governance-focused assessments must be balanced with other performance metrics, as substantial compliance alone does not necessarily translate to superior operational or financial outcomes.

Subsequent advancements have greatly helped in assessing CEO performance in data-driven policies. Social network analysis and machine learning shed light on trends in executive decision-making and business objective alignment (Aggarwal & Samwick, 2003). These tools provide an evidence-based answer to measurement of performance by analyzing big data and identification of leadership qualities that make or break success. For instance, machine learning algorithms can analyze how CEO decision-making practices affect company performance. In contrast, social network analysis tracks the influence and strategic positioning of CEOs by examining their interactions with important stakeholders and their peers in the same industry. These technological advances present objective feedback but are also under some limitations, such as sparseness of data available, bias in interpretation, and leadership complexity.

Qualitative evaluations, including surveys and stakeholder interviews, provide more details on a CEO's leadership style, strategic vision, and interpersonal abilities. Mintzberg (1973) argues that CEO efficiency cannot be measured solely through quantitative data, as communication abilities, adaptability, and decision-making under uncertainty also shape leadership effectiveness. Employee, board member, and industry analyst surveys can provide insights into how well a CEO leads, highlighting their strong points and potential areas for development. Stakeholder interviews give financial and governance indicators a more complex context, enabling a deeper understanding of management. However, because opinions about CEO performance can be affected by outside variables like media attention, the state of the economy, or company culture, qualitative evaluations are at risk of biases. Objective performance metrics should be combined with qualitative insights to reduce these biases.

Longitudinal observations of organizational resilience in times of crisis provide an active perspective on CEO effectiveness. Finkelstein et al. (2009) note that a CEO's capacity to stay alive through bad times, acclimatize to changing currents in the marketplace, and achieve organizational stability is the objective criteria of his effectiveness. Examining a CEO's reaction to industry changes and fluctuations in finances offers crucial indicators of resilience as a leader and planning strategically; CEOs that exhibit good risk-management skills are proven by those who lead companies out of turmoil successfully with increased

efficiency. Longitudinal analysis, nonetheless, requires longer intervals of observation and is less useful when examining the effectiveness in the short-term of performance.

In general, measurement at the CEO level must be conducted through a holistic and multi-dimensional process incorporating crisis-response measurement. While financial measures are most common as a measurement method, they do not have the depth to comprehend executive leadership. Non-financial measurements, governance analysis, and technological breakthroughs fill this gap, enabling firms to completely understand CEO performance. By developing a thorough framework of evaluation, businesses can make well-informed decisions about the effectiveness of their CEOs. This will guarantee that executive compensation quality and firm planning. However, this research finds that there is an assumption behind the efficient CEO that is the CEO who maximizes the lowest economic resources so as to make more economic returns and thus receives lower aggregate compensation and turns this assumption into a helpful indicator.

### 2.2.8. Benchmarking CEOs.

CEO compensation is increasingly decided by benchmarking CEO performance. Companies try to equate executive compensation with value creation and strategic performance by comparing the CEO's performance to peers within the industry. This theoretical approach uses economic theories to analyze the linkage between CEO compensation and benchmarking processes. The benchmarking of CEO compensation is addressed in the literature through a number of theoretically supported models. These models, however, are not without controversy as they represent ongoing debates within the field. In contrast, evaluating the performance of rival firms' performance measures to identify the contribution of the CEO to financial and accounting performance is relevant to remuneration committees.

According to agency theory (Holmstrom, 1982; Holmstrom & Milgrom, 1987), CEOs could be motivated and insured against joint risk by cross-sectional comparison of firm performance measures and peer performance measures, which would equate to more effective compensation contracts. As peer performance measures are indicative of the same dimension as own-firm performance measures, the top management will be compensated for

measurable success in the best interests of the principal, i.e., accounting earnings. According to Nam (2020) argues that soundly analogous peer accounting measures recommend additional evidence meriting CEO compensation schemes. Additionally, the research reveals that comparability of accounting measures is a critical factor that enables the use of peer accounting measures to evaluate CEO performance. But through applying solid geometry to bridge the two most prominent determinants of CEO pay (firm performance and firm size), this paper would like to be able to derive a mathematical equation that will facilitate comparisons of CEO pay with other similar firms.

This equation will allow companies to choose a benchmark company and calculate its CEO effectiveness without applying a market regression line, irrespective of the size of the company (small or large). In addition, Aguinis et al. (2018) suggest that boards generally apply the industry average in determining the pay package of the CEO; boards generally apply the industry average. However, this method will overpay underperforming CEOs or below-average performers. Ron (2013) observes the variables that determine a firm's selection of benchmark for CEO compensation. A recent rule change in the SEC's filing requirements enabled me to construct a new data set that captures the actual comparison group selected by each company. The evidence indicates that firms are more likely to select larger firms and firms that paid their CEOs well once firm attributes such as own size and executive compensation are held constant; but then what if the strategy selects a wrong benchmark as the small firm may have an even better CEO? Nonetheless, the CEO compensation literature has several models that subject the benchmarking process to testing and a series of determinants of executive remuneration. The models provide a structured approach through which one can enjoy the appreciation of how firms select peer groups, determine pay benchmarks, and construct compensation arrangements relative to industry practices, firm size, and performance metrics.

#### 2.2.8.1. Peer Group Comparison Model (Bizjak et al., 2008)

According to Bizjak et al. (2008), executive compensation design has been a central topic of discussion in academic and professional circles due to its implications for corporate governance, firm performance, and managerial incentives. The study examines how peer groups and competitive benchmarking influence CEO pay levels and the overall

compensation-setting process. Specifically, the study analyzes how firms determine executive compensation through external comparisons, as disclosed in compensation committee reports found in firms' proxy statements. The findings indicate that peer group benchmarking is widely adopted in executive pay design.

Utilizing comprehensive data from Execucomp covering 1992–2005, the study provides empirical evidence that peer groups and competitive benchmarking significantly impact CEO pay adjustments. The results show that CEOs whose compensation falls below the median of their peer group receive considerably higher pay raises than those whose compensation is above the peer group median. This pattern persists even after controlling other determinants of executive compensation, such as firm performance, size, and governance factors.

However, competitive benchmarking has several limitations, including the potential to increase CEO compensation regardless of business performance, which could lead to inefficiencies in the pay structure. The study supports this latter viewpoint by demonstrating that CEOs with below-median pay are more likely to receive salary adjustments that move them above the median level when their firms perform well and when labor market constraints are tighter. Crucially, the idea that CEOs influence the pay-setting process to serve their own benefit is rejected by the lack of systematic evidence connecting benchmarking practices to inadequate corporate governance.

Additionally, the findings demonstrate that competitive benchmarking serves as a retention mechanism, which contributes to the explanation of the pay-for-luck relationship's observed asymmetry. Specifically, the findings indicate that the asymmetry in CEO pay adjustments due to luck (external market conditions) is primarily present among CEOs whose compensation is below the median of their peer group. Contrary to the argument that this asymmetry results from CEOs capturing the pay process, the analysis suggests that firms adjust compensation levels to retain executives in response to external labor market conditions and industry fluctuations.

Although the findings support the role of benchmarking in establishing competitive executive compensation, the study acknowledges that its widespread use may have

contributed to an overall increase in CEO pay levels beyond what would have occurred in its absence. However, determining the precise extent of this effect remains challenging, as it is difficult to imagine how firms could assess market wages without some form of external comparison. While prior studies have linked the sharp rise in CEO pay to evolving labor market dynamics, none have specifically examined the role of peer group benchmarking in this process.

By illuminating the ways in which benchmarking affects compensation structures, Bizjak et al. (2008) add to the continuing discussion surrounding executive compensation. Future studies could look at more cost-effective ways to collect data on market wages and consider different strategies for determining executive compensation that strike a balance between firm performance incentives and competition.

$$\Delta \text{Compensation}_{it} = \alpha + \beta 1 * \text{Luck} + \beta 2 * \text{Skill} + \beta 3 * (\text{Luck} \times \text{Luck Down}) + \beta 4 * (\text{Skill} \times \text{Skill Down}) + \beta 5 * (\text{Luck} \times \text{CDF Variance Luck}) + \beta 6 * (\text{Skill} \times \text{CDF Variance Skill}) + \text{Control Variables} + \epsilon$$

Where:

**$\Delta$ Compensation $_{it}$ :** Change in compensation for CEO i at time t.

**Luck:** Component of firm performance attributed to external factors beyond the CEO's control (e.g., industry-wide trends).

**Skill** : Component of firm performance attributed to the CEO's actions and decisions.

**Luck Down:** dummy variable equal to 1 if Luck is negative (i.e., adverse external conditions), and 0 otherwise.

**Skill Down**: dummy variable equal to 1 if Skill is negative (i.e., poor performance due to CEO decisions), and zero otherwise.

**Variance Luck**: Cumulative distribution function of the variance of the luck component, representing the relative position of the firm's luck variance within the sample.

**CDF Variance Skill:** Cumulative distribution function of the variance of the skill component, representing the relative position of the firm's skill variance within the sample.

**Variables**: A set of control variables influencing CEO compensation, such as firm size, industry, and governance characteristics.

**ϵ**: Error term capturing unobserved factors affecting compensation.

**β1\beta 1and β2\betaβ2:** These coefficients measure the sensitivity of CEO compensation to changes in luck and skill, respectively. A positive β1\beta_1β1 suggests that compensation increases with favorable external conditions, while a positive β2\beta_2β2 indicates that compensation rises with improvements attributed to the CEO's skill.

**β3\beta 3 and β4\beta 4**: These coefficients capture the interaction effects between the performance components (luck and skill) and their respective downturns. Specifically, β3\beta_3β3 assesses how compensation responds to adverse external shocks (bad luck), and β4\beta_4β4 evaluates how compensation adjusts to poor performance resulting from the CEO's decisions (lack of skill).

**β5\beta5 and β6\beta 6**: These coefficients examine how the variability (uncertainty) in luck and skill influences compensation. By interacting with the performance components with the cumulative distribution function of their variances, the model assesses whether higher uncertainty in external conditions or CEO performance impacts compensation decisions.

To conclude. Bizjak et al. (2008) examine how companies benchmark CEO compensation using peer groups and whether this practice results in higher pay and less effective compensation structures. In order to comprehend the factors that determine executive compensation, they examine the relationship between CEO compensation and elements like skill and luck, taking into account both their direct effects and interactions. However, Bizjak et al. (2008) find that using peer groups is pervasive, with firms typically choosing peers based on similarities in industry and size. Thus, they control the size while the size is a primary predictor variable in CEO contracting.

#### 2.2.8.2. Performance-Based Benchmarking (Bebchuk & Fried, 2004)

Bebchuk and Fried (2004) analyze how executives' excessive control over their compensation has resulted in major pay structure errors due to corporate governance weaknesses. The book challenges the traditional "arm's length contracting" model, which assumes executive compensation is determined through independent negotiations between executives and boards. Instead, the authors argue that corporate boards often fail to operate independently from the executives they oversee, allowing managerial power to shape compensation arrangements in ways that prioritize executive interests over those of shareholders. The authors argue that recent governance reforms have attempted to increase executive compensation transparency and board scrutiny. However, they are insufficient to eradicate the pay-firm performance discrepancy. They highlight that neither market force nor shareholder intervention imposes sufficiently strong constraints to prevent excessive or poorly structured executive compensation.

A central theme of the book is how managerial power influences the design of executive compensation packages. Bebchuk and Fried argue that executives have a vested interest in disguising the magnitude of their compensation and the extent to which it is insulated from firm performance. The strategic use of stock options, retirement benefits, and other opaque pay structures that hide compensation are only a few of the methods examined in the book to accomplish this. The authors further demonstrate how managerial influence affects compensation processes by allowing CEOs to negotiate severance packages beyond their contract rights. By providing a framework to assess whether pay arrangements result from managerial power, Bebchuk and Fried shed light on how executives influence compensation policies to their advantage, often at the expense of shareholders.

The book also explores how executive influence has weakened the link between pay and performance. Bebchuk and Fried analyze various compensation components, including non-equity compensation, stock options, and restricted stock grants, and show how their design allows executives to receive substantial pay regardless of firm performance. They discuss how managerial influence has shaped conventional stock option plans in ways that benefit executives even when company performance declines. They also discuss how executives exploit their discretion in selling shares and exercising options to maximize

personal gains. These findings suggest that existing compensation structures often fail to serve as actual performance incentives and instead enable executives to secure high pay levels with minimal risk exposure.

The authors provide many improvements to enhance corporate governance and CEO compensation in the concluding section. They support more transparency, more stringent board supervision, and requiring shareholder consent for important remuneration choices. However, they argue that these positive actions alone are insufficient. In order to effectively address the structural issues with executive compensation, boards must be independent of executives and answerable to shareholders. In order to make sure that directors put shareholder interests first when deciding CEO compensation, the authors propose that legislative safeguards shielding directors from investor influence be reexamined. Businesses can design compensation plans that match CEO compensation to business performance by increasing corporate boards' responsiveness to shareholders. Thus, Bebchuk and Fried (2004) focus on qualitative assessments and theoretical frameworks rather than developing or applying specific econometric models. They demonstrate traditional "arm's length contracting" models.

#### 2.2.8.3. Market Median Benchmarking (Gabaix & Landier, 2008)

Gabaix and Landier (2008) developed a competitive model of CEO compensation that delivers an analytically tractable and calibratable framework for the relationship between CEO pay and firm size. The model relies on extreme value theory, which is applied to obtain a micro-founded hypothesis for the distribution of CEO talent and its influence on executive compensation. With this approach, the authors obtain closed-form expressions for equilibrium CEO pay, which allows them to analyze how executive compensation varies and differs across firms and countries. Among their main findings is that the growth in CEO pay in the recent decades is largely accounted for by the extremely big growth in firm size and less by alternative explanations, such as managerial rent extraction, increased power in the executive labor market, or the diffusion of incentive-based compensation plans.

The framework offers an explanation for the determinants of CEO compensation in a competitive market among companies for superior executives. Since the decision-making capacity of a CEO significantly affects the company size, it thus implies that companies with

bigger market capitalization can pay more in order to obtain the best executives; the framework argues that the correlation explains the positive relationship between CEO compensation and company size. Beyond CEO compensation, Gabaix and Landier (2008) propose that their model can be used to study the compensation structure of high-level executives and evaluate outside opportunities—such as those available in the money management industry- that affect executive compensation levels.

The article also discusses the impact of stock option price assumptions on compensation plans. The assignment of CEO talent and its overall economic effects are examples of basic macroeconomic and corporate finance determinants that can be used as a channel. Among the contributions of Rosen (1982) is the application of extreme value theory to CEO economics. The study creates opportunities for additional empirical and analytical research on the topic by demonstrating the connection between extreme value distributions and market demand for executive talent.

This approach provides a valid mathematical foundation for studying other superstar markets, including entertainment, sports, and investment management, in which disproportionately large compensation is earned by a small group of extremely gifted individuals. The model provides a case for the CEO compensation in its theoretical applicability and empirical applicability, providing an insight into the underlying economic forces behind executive compensation trends globally. They thus have a tendency to focus on firm size when benchmarking executive compensation. According to their theory, larger companies are ready to pay more in order to obtain top executive talent because a skilled CEO can significantly add value to a very large company. Although the model highlights the relationship between company size and CEO pay, it does not explicitly incorporate the firm's performance in selecting benchmarks for pay. Instead, the authors argue that the significant increase in CEO compensation in the last decades is mostly attributable to the increase in firm sizes rather than being the result of factors like managerial rent extraction or better incentive-based compensation plans.

#### 2.2.8.4. Equity-Based Benchmarking (Jensen & Murphy, 1990)

Jensen and Murphy (1990) define equity-based benchmarking as a pay model that specifically links executive compensation to shareholder value through stock-based

incentives. By balancing their interests with those of shareholders, this approach guarantees that CEOs are paid for long-term value creation rather than short-term financial performance. Jensen and Murphy (1990) analyze the relationship between CEO compensation and firm performance across five decades, revealing a weak correlation between executive wealth and shareholder value. Their findings indicate that, on average, a $1,000 change in shareholder wealth corresponds to only a two-cent increase in CEO salary and bonus, while total CEO wealth, including stock options and future compensation adjustments, changes by approximately 45 cents per $1,000 in shareholder wealth for the entire sample, with lower sensitivity in large firms and higher sensitivity in small firms.

Additionally, the study estimates that CEO dismissal-related wealth consequences further contribute to a total pay-performance sensitivity of approximately 75 cents per $1,000 change in shareholder wealth. The most significant performance incentives for CEOs stem from stock ownership; however, CEO shareholdings are generally low and have declined over time, with median insider stock ownership at just 0.25% in 1986. The study also finds that boards of directors do not adjust pay-performance sensitivity based on CEO share ownership. While bonuses constitute a substantial portion of CEO compensation, they are not strongly linked to firm performance. Furthermore, the variability in CEO pay changes is low, resembling that of a random sample of workers, suggesting that compensation structures do not effectively reward exceptional performance. The historical analysis reveals a significant decline in pay-performance sensitivity, with top-quartile CEOs seeing their performance-related pay drop from 17.5 cents per $1,000 in shareholder wealth in the 1930s to just 1.9 cents per $1,000 by the 1980s, despite firm market values doubling over the same period. According to Jensen and Murphy (1990), there may be a lack of alignment between CEO incentives and shareholder interests due to political pressures at the regulatory and corporate levels that limit significant performance-based bonuses. They argue that the dynamics of the managerial labor market, company governance, and the larger field of executive compensation research are all challenged by the absence of effective pay-for-performance systems.

- **The model:**

$$\Delta(\text{CEO pay-related wealth}) = \text{total pay} + PV[\Delta(\text{salary}+\text{bonus})] + \Delta(\text{value of stock options})$$

The model incorporates various compensation components and represents how a CEO's pay-related wealth changes over time. It accounts for current earnings, future expected changes, and variations in stock option values, making it a more dynamic measure of executive compensation.

Where:

**Total Pay**: This represents the CEO's current compensation, including base salary, annual bonuses, and direct cash payments. It also reflects the immediate income the CEO earns in a given period.

**PV [Δ (Salary + Bonus)]:** This term represents the present value (PV) of expected future changes in salary and bonus. This term accounts for those future increases since a CEO's salary and bonus can increase over time due to performance incentives, inflation adjustments, or contract renegotiations. The present value (PV) ensures that future earnings are discounted to reflect today's worth.

**Δ (Value of Stock Options):** This term measures the change in the value of the CEO's stock options over time. Stock options are a significant component of executive compensation, allowing CEOs to purchase company shares at a fixed price. If the company's stock price increases, the value of these options rises, leading to a higher wealth gain for the CEO. Conversely, if stock prices decline, the value of stock options decreases. This component captures the equity-based incentives that align CEO pay with shareholder value.

However, the model gives a dynamic view of how compensation changes over time by quantifying the overall change in CEO wealth due to compensation changes. It points out how the determinants, such as pay increases, performance bonuses, and stock market movements, drive CEO compensation, which is not fixed. CEO compensation and shareholder returns are positively correlated by including stock options, so that the model captures the effect of firm performance on CEO wealth. The model is significant in understanding how pay trends change over time and the responsiveness of CEO compensation to firm performance. Compounding salary adjustment, bonus changes, and

stock option amounts provides a full measure of CEO wealth dynamics and thus is a critical tool for corporate governance and executive compensation research. Jensen and Murphy (1990) therefore miss that firm size is a significant predictor of CEO pay.

#### 2.2.8.5. Relative Performance Evaluation (RPE) Model (Faulkender & Yang, 2010)

Faulkender and Yang (2010) examine how firms determine CEO compensation based on comparisons with peer companies. While many firms claim to set executive pay by analyzing compensation at similar organizations, only recently has this process become more transparent due to increased disclosure of peer group selections. Their study is the first to demonstrate that the actual composition of compensation peer groups significantly influences the variation in observed CEO pay. By analyzing compensation peer group characteristics and their selection criteria, the authors find that, in addition to industry and firm size, the level of CEO pay at potential peer companies also plays a crucial role in peer selection. Specifically, firms tend to choose highly paid peers to justify higher CEO compensation, an effect that is particularly pronounced in firms with smaller peer groups, CEOs who serve as board chairmen, longer-tenured executives, and board members who hold multiple directorships. Using a propensity score matching approach, the study reveals that the median firm selects a compensation peer with a median total pay $470,000 higher than its best-matched unselected peer. This pays differential accounts for 5.6% of the mean CEO pay ($8.383 million) and 7.7% of the median CEO pay ($6.085 million) in the sample. Moreover, selecting higher-paid peer firms results in an estimated 3.3–4.5% annual increase in CEO compensation, contributing to the ratcheting effect, where CEO pay increases over time due to the benchmarking process. CEO pay increases by approximately 0.581% for every 1% increase in median peer pay.

Furthermore, firms can further inflate CEO pay by setting compensation benchmarks above what would be justified by their size ranking within the peer group. For example, a firm positioned in the bottom quartile of its peer group may still benchmark CEO compensation against the median pay of its selected peers, artificially elevating executive pay. However, when examining a subsample of 429 firms that disclosed benchmarking information, the study does not find a systematic bias in setting pay benchmarks, particularly for selected peers where size or pay data was unavailable (around 6% of selected peers).

Overall, the findings suggest that the CEO pay-setting process does not entirely align with the efficient market explanations proposed by Gabaix & Landier (2008). It is also not as fully manipulated as Bebchuk and Fried (2004) argued. Due to the enhanced transparency in peer-group disclosures, the benchmarking process may be subject to investigation by shareholders and other stakeholders.

- **The model:**

The model estimates the probability that a potential peer firm (j) is chosen as a member of the compensation peer group for firm (i). The dependent variable takes a value of one if firm j is selected as a compensation peer for firm i, and zero otherwise. The selection of peers is influenced by several independent variables that capture industry similarity, firm size, market presence, CEO characteristics, and executive mobility. The model is specified as follows:

$$\text{Peer Chosen} = \alpha + \beta_1 \text{ Industry Match 2D} + \beta_2 \text{ Industry Match 3D} + \beta_3 \text{ Sales Size Match} + \beta_4 \text{ Assets Size Match} + \beta_5 \text{ Market Cap Size Match} + \beta_6 \text{ Dow30 Match} + \beta_7 \text{ SP500\_Match\_ij} + \beta_8 \text{ SPMidCap400\_Match\_ij} + \beta_9 \text{ CEO Chair Match} + \beta_{10} \text{ CEO Not Chair Match} + \beta_{11} \text{ Talent Flow} + \beta_{12} \text{ Total Peers} + \varepsilon$$

Where:

**Peer Chosen**: A binary dependent variable that equals one if firm j is selected as a compensation peer for firm i, and zero otherwise.

**Industry Match 2D**: A binary variable indicating if firms i and j share the same two-digit SIC industry code.

**Industry Match 3D**: A binary variable indicating if firms i and j share the same three-digit SIC industry code.

**Sales Size Match**: A binary variable equal to 1 if firm j has sales within 50%-200% of firm i.

**Assets Size Match**: A binary variable equal to 1 if firm j has total assets within 50%-200% of firm i.

**Market Cap Size Match**: A binary variable equal to 1 if firm j has market capitalization within 50%-200% of firm i.

**Dow30_Match**: A binary variable equal to 1 if both firms belong to the Dow 30 Index.

**SP500_Match**: A binary variable equal to 1 if both firms belong to the S&P 500 Index.

**SPMidCap400_Match**: A binary variable equal to 1 if both firms belong to the S&P Mid Cap 400 Index.

**CEO Chair Match**: A binary variable equal to 1 if both firms have CEOs who are also board chairmen.

**CEO Not Chair Match**: A binary variable equal to 1 if both firms have CEOs who are not board chairmen.

**Talent Flow**: A binary variable equal to 1 if at least one of the top five executives moved between the firms from 1992-2005.

**Total Peers**: A continuous variable representing the total number of peers selected by firm i, which may influence the probability of firm j being chosen.

**ε**: The error term, accounting for unobserved factors affecting the selection of peers.

#### 2.2.8.6. Strategic Efficiency Benchmarking Model for CEO Compensation (Oberholzer, 2016)

successfully develops a benchmarking model for CEO compensation by employing Data Envelopment Analysis (DEA), integrating two strategic approaches—cost leadership and differentiation—to assess executive pay. In the cost leadership strategy, firms signal that their CEOs are compensated based on best practices, ensuring they are not overpaid. Conversely, the differentiation strategy indicates that a firm's CEO is above average and, thus, compensated accordingly.

The study utilizes a two-stage model. In Stage 1, an input-oriented DEA model is applied. Firms A, D, and E are positioned on the efficiency frontier, indicating that they align with either cost leadership or a differentiation strategy. If a firm follows cost leadership, it ensures that CEO pay is consistent with industry standards, while firms adopting a differentiation strategy must adjust their position to remain below the benchmark line. Meanwhile, Firms B and C may choose a differentiation strategy, maintaining some distance from the benchmark, or a cost leadership strategy, requiring adjustments to move toward the

benchmark. Regardless of the selected strategy, the second stage of the model assesses the efficiency of converting firm resources into performance outcomes—either accounting-based or market-based metrics.

Stage 2's output-oriented approach evaluates how effectively firms transform their resources into performance yields. Firms A and D appear on both benchmark frontiers, signifying their ability to operate as efficient cost leaders while effectively converting resources into firm performance. Firm B, which follows a differentiation strategy, is also efficient in resource utilization. However, Firm C, which also adopts differentiation, is inefficient in translating firm resources into performance, while Firm E, applying cost leadership, similarly struggles with efficiency in resource conversion.

The primary contribution of this study is developing a model that links CEO pay efficiency with a firm strategy yet remains independent of the preferred compensation strategy. By claiming that their CEO is superior to the industry average and should be compensated appropriately, companies that choose differentiation seek to send a favorable message to the market. In the meantime, companies that seek cost leadership also give the market a good indication by showing that their CEO is paid relatively and following industry standards.

One of the study's limitations is that it considers only a limited set of CEO pay determinants, suggesting that future research could refine the model by incorporating additional variables. The study also challenges traditional linear regression analysis approaches in CEO pay-performance studies. This can create a misleading perception where CEOs below the regression line may be viewed as underpaid. In contrast, those above the line are perceived as deserving higher pay. This fuels the Lake Wobegon effect, where firms continuously escalate executive compensation without strong performance justification. By applying DEA, this model helps firms whose CEOs fall into the lower half of their peer group to signal a positive market message, thereby countering the persistent rise in executive pay without corresponding performance improvements. The model uses a two-dimensional graph with the highest net profit, the smallest firm size, and the same compensation as the benchmark firm.

### 2.2.9. Benchmarking CEOs and Firm Performance.

One essential method for assessing executive effectiveness and ensuring that leadership results align with business goals is to benchmark CEOs according to firm performance. Using financial measures as major success indicators, performance benchmarking offers an organized way to evaluate how well CEOs carry out corporate strategies compared to peers in the sector. According to Kaplan and Norton (1996), return on equity, return on assets, and earnings per share are used to evaluate performance objectively. The ability of a CEO to manage resources and increase profitability is reflected in these measurements, which are recognized as essential indicators of operational effectiveness. While ROE evaluates profitability concerning equity and is a crucial indicator of value creation for investors, ROA demonstrates how well a CEO uses firm assets to produce earnings. Additionally, EPS helps to connect CEO performance with investor interests by offering information about creating shareholder value (Kaplan & Norton, 1996).

Benchmarking against industry peers enables boards of directors to determine whether a CEO's leadership yields competitive outcomes, directly informing performance-based compensation decisions. CEO bonuses have a considerable beneficial impact on following ROA, according to a systematic review by Rousseau et al. (2023), confirming the success of tying compensation to performance results. Therefore, benchmarking reduces the possibility of overpaying or underpaying CEOs by ensuring that compensation plans are based on market-based norms. Additionally, peer benchmarking supports boards in determining performance gaps and assessing how well the CEO works compared to peers. This comparison method is helpful in sectors with intense competition since it shows whether poor performance is due to a lack of leadership or more general market trends (Rousseau et al., 2023).

Benchmarking promotes responsibility beyond compensation by creating valuable performance indicators, promoting goal-oriented leadership, and sharpening strategic focus. Epstein and Roy (2001) emphasize that performance assessments and other benchmarking frameworks help CEOs evaluate progress toward established targets, increasing executive accountability. CEOs are more likely to adopt long-term, sustainable strategies when their performance is evaluated against consistent and transparent benchmarks. Such accountability

mechanisms also facilitate stakeholder communication by providing clear, measurable outcomes that can be shared in corporate reports and shareholder meetings (Epstein & Roy, 2001). Additionally, benchmarking can identify areas for leadership development, enabling boards to set targeted improvement goals for underperforming executives.

However, the effectiveness of performance benchmarking is highly dependent on selecting appropriate performance metrics that capture both short-term results and long-term value creation. According to Edmans and Gabaix (2016), while performance-linked bonuses can effectively drive profitability, overreliance on stock options may incentivize short-term decision-making that prioritizes immediate gains at the expense of sustainable growth. For example, CEOs who are overly focused on stock price performance may resort to earnings manipulation or share buybacks to boost short-term results, undermining long-term shareholder value. Edmans and Gabaix (2016) suggest a comprehensive approach that aligns CEO incentives with long-term company performance by incorporating multi-year performance metrics and long-term equity compensation into compensation plans.

Benchmarking against peers also facilitates the identification of best practices, enabling CEOs to adopt strategies that drive competitive advantage. Firms that regularly compare their methods for leadership to those of top performers are better positioned to execute successful plans and achieve long-term growth, according to Collins (2001), who emphasizes the value of learning from industry leaders. Peer comparisons could highlight better operational models, creative market strategies, or efficient cost-management strategies that can be modified to improve organizational performance. Additionally, CEOs can predict changes and keep a competitive edge by using benchmarking to find new trends and changes in industry norms (Collins, 2001).

Furthermore, CEO benchmarking facilitates continual improvement by establishing a feedback loop between strategic decision-making and performance outcomes. CEOs who routinely evaluate their performance compared to their peers have important knowledge about their competitive position, which can guide changes to company strategy. This continual cycle of assessment, modification, and improvement drives organizational

flexibility and adaptability, which helps businesses efficiently react to shifts in the market and pressure from competitors (Kaplan & Norton, 1996).

In summary, benchmarking CEOs using firm performance is a key governance instrument that connects executive compensation to business success and develops accountability. It ensures executive compensation reflects actual contributions to corporate success by giving performance evaluation a data-driven foundation. Additionally, Benchmarking provides innovation by enabling peer comparisons, which promotes continuous growth and competitive advantage. However, a balanced strategy that incorporates both short-term and long-term performance is necessary for benchmarking to be effective.

### 2.2.10. Benchmarking CEOs and Firm Size.

Because it directly impacts the complexity of managerial duties and the range of leadership problems, firm size is an important consideration when benchmarking CEOs. CEOs of larger companies must possess sophisticated managerial abilities, industry knowledge, and a strong capacity to manage scale and complexity. These companies usually confront more complicated operational, financial, and strategic difficulties (Tosi et al., 2000). According to Tosi et al. (2000), larger firms demand broader managerial competencies due to their diversified operations, global presence, and increased stakeholder expectations, raising CEOs' performance bar. CEOs of large corporations are expected to navigate complex organizational structures, manage a broader range of business units, and lead across international markets. This justifies benchmarking their performance against peers with similar organizational scales.

The relationship between firm size and CEO compensation is well-established. Gabaix and Landier (2008) demonstrate that CEO pay increases proportionally with firm size, resulting from market-based matching between the most talented CEOs and the largest firms. Because larger firms may obtain more value from a CEO's expertise, their competitive model shows that even small changes in firm size can significantly increase CEO pay" Butterfly Effect". Additionally, their research shows that the rise in average firm size over the past few decades has been a primary driver of the dramatic increase in CEO compensation. This

supports the notion that benchmarking CEO performance should account for firm size, as larger firms require leaders capable of managing greater complexity and generating higher returns from a broader asset base.

Firm size also impacts the selection of peer groups for benchmarking, as comparisons are most meaningful against companies of similar scale, industry, and operational complexity. According to Becker (1964), human capital theory explains that larger firms attract and compensate CEOs with superior managerial skills, technical expertise, and extensive industry experience due to the heightened challenges of leading large-scale organizations. In order to make sure that performance reviews and pay plans align with the knowledge and expertise required to handle complexity, human capital theory highlights that companies should compare CEOs to peers with similar human capital needs. Peer selection is critical in benchmarking processes, as inappropriate comparisons with smaller or less complex firms can distort performance evaluations and compensation decisions.

Larger firms are also more likely to utilize sophisticated performance metrics in their benchmarking models to capture the multifaceted nature of leadership effectiveness. Kaplan and Norton (1996) advocate for comprehensive performance measurement systems, such as the Balanced Scorecard, which includes financial and non-financial metrics like Economic Value Added (EVA) and Total Shareholder Return (TSR). These metrics are particularly relevant for larger organizations where leadership effectiveness extends beyond short-term profitability to encompass strategic execution, operational efficiency, customer satisfaction, and innovation. For instance, EVA measures a firm's economic profit and is a strong indicator of a CEO's ability to create shareholder value above the firm's cost of capital. Similarly, TSR is a metric for comparing CEOs in big companies with a range of business operations since it accounts for the entire return produced for shareholders, which includes both dividends and stock price growth.

From a compensation perspective, research shows that larger firms offer higher pay packages, reflecting the increased demands and risks of managing complex organizations. According to Jensen and Meckling (1976), agency theory posits that larger firms face more significant agency problems due to their size, complexity, and separation of ownership and

control. Consequently, performance-based compensation mechanisms such as stock options, long-term equity incentives, and performance-linked bonuses are necessary to align the interests of CEOs with those of shareholders. This theory supports benchmarking practices that compare compensation structures across firms of similar size to ensure that pay levels are competitive and performance driven. Benchmarking can also help boards determine if their CEO compensation practices align with market standards, reducing the risk of under- or overcompensation.

However, Bebchuk and Fried (2004) argue that managerial power theory suggests that CEOs in larger firms may leverage their influence over boards of directors to negotiate excessive pay packages, regardless of performance. Due to their dispersed ownership structures and weaker shareholder oversight, larger firms may be more susceptible to managerial entrenchment, where CEOs use their power to shape compensation practices in their favor. Additionally, Bebchuk and Fried (2004) argue that benchmarking processes can be manipulated if peer groups are selected strategically to justify higher pay. For example, some companies may select peers with abnormally high CEO compensation, inflating standards and fueling the upward cycle of executive pay. This emphasizes how crucial it is to compare CEO performance and compensation within peer groups of comparable size and complexity using exacting and impartial benchmarking procedures.

Additionally, firm size can introduce challenges related to performance attribution, where the success of a large organization may not solely reflect the CEO’s effectiveness. Utilizing benchmarking criteria that separate the CEO's contribution from more general organizational and market dynamics is crucial since external factors like market trends, industry cycles, and macroeconomic conditions can significantly impact a company's performance. Long-term performance indicators and multi-year benchmarking frameworks can help account for these factors, ensuring that CEO evaluations are fair and reflect actual leadership impact.

In conclusion, firm size is crucial when comparing CEO performance because it directly impacts leadership responsibilities, peer group selection, performance measurement criteria, and compensation structures. Comparing CEOs to peers handling comparable

organizational difficulties is crucial because larger companies require more sophisticated managerial skills. Effective benchmarking techniques must balance these viewpoints with exacting procedures and thorough performance metrics, even though theories like agency, human capital, and managerial power theory offer insightful information about the connection between firm size and CEO benchmarking. Performance reviews and pay decisions are fair, competitive, and in line with the size and complexity of the organization when firm size is appropriately incorporated into benchmarking.

### 2.2.11. Why Mathematical Modeling?

The editors of the Journal of Mathematics have published a special issue to justify the use of mathematical modeling in the financial fields. Chen et al. (2022) argue that Mathematical models serve as essential tools for the quantitative analysis of various objective problems, particularly in the financial sector. These models, which are now crucial in modern financial research and practice, can help professionals better understand complex financial phenomena. Researchers and analysts can improve their comprehension of financial and market trends to aid in decision-making by creating mathematical models that outline the functional relationships between financial variables.

The constant developments in mathematical modeling and technological advancements have generated new and changing problems in financial problem-solving. As financial markets become more complicated, mathematical models must also change to account for dynamic variables and erratic changes in the economy.In financial research, mathematical modeling is regarded as one of the most effective methods for systematically analyzing and resolving financial problems. These models offer an organized framework that aids in the development of predictive algorithms for decision-making, the quantification of financial data, and the evaluation of possible risks. By applying mathematical models, financial analysts can dissect intricate economic relationships, validate theoretical assumptions, and improve the accuracy of financial forecasting. Moreover, mathematical modeling enables financial professionals to conduct scenario analysis, stress testing, and sensitivity assessments, contributing to more informed investment strategies and risk management decisions. The ability to apply mathematical models in finance fosters a more scientific approach to addressing financial uncertainties and optimizing resource allocation.

Furthermore, Mathematical models can be applied in a variety of financial research domains, including investing, risk management, stock market analysis, and financial credit evaluation. For example, by examining borrower behavior and forecasting loan defaults, mathematical models can improve credit management. In securities trading, these models facilitate automated trading, trend detection, and portfolio optimization. They are also crucial for assessing the safety of financial transactions conducted online, helping financial institutions lower cyber risks, and safeguarding digital assets. A more organized and data-driven financial system results from using mathematical models to assist decision-making in corporate accounting, insurance pricing, bond investment, and general financial planning.

Thus, this special Issue aims to compile original research and review articles focusing on applying mathematical models in financial problem-solving. The scope includes various financial domains, such as banking, investment, insurance, corporate finance, and economic policy. Researchers and scholars are encouraged to submit their findings on using mathematical models in financial analysis, covering interdisciplinary topics that intersect finance, economics, management, and applied mathematics. This issue seeks to address contemporary financial challenges through quantitative approaches by highlighting the latest advancements in mathematical finance. Potential topics for research contributions include, but are not limited to, the following: optimization of financial credit management using mathematical models, stock trading data analysis based on quantitative modeling, security risk assessment in internet finance, project investment risk analysis, supply and demand forecasting in market economies, cost-profit analysis in financial planning, option pricing and default risk assessment, optimization of commercial bank management, and the role of mathematical models in enterprise financial management. This article offers important insights into how mathematical finance develops and can be used practically in financial decision-making.

- **Solid Geometry and CEO Compensation**

The study of three-dimensional shapes, including their measurements of relationships, is the focus of the mathematical field of solid geometry. In contrast with plane geometry, which deals with two-dimensional figures, solid geometry studies objects such as cubes, spheres, cylinders, and pyramids, emphasizing concepts like volume, surface area, and cross-

sections. Understanding solid geometry is essential in many fields because it allows for modeling and analysis of spatial arrangements. In order to improve problem-solving and mathematical abilities, studying solid geometry involves transformations like rotations, reflections, and translations in three dimensions (Moise, 1990).

However, since financial analysis mostly depends on numerical data, statistical models, and two-dimensional visualizations like charts and financial statements, solid geometry is not frequently used in the accounting and finance fields. Relatively little is known about the application of three-dimensional geometric concepts in financial research, especially when it comes to executive compensation and its connections to firm size and performance. To the best of my knowledge, by addressing these variables as interrelated dimensions within a spatial framework, this study is the first to use solid geometry to analyze the mathematical relationships between them. This study intends to provide a new viewpoint on how CEO compensation varies with firm size and performance by utilizing solid geometry concepts. It may also reveal trends and insights that traditional financial analysis techniques could fail to find.

### 2.2.12. CEO Compensation in Dow Jones Industrial Average

Often referred to as the Dow Jones, the Dow Jones Industrial Average (DJIA) is a stock market index that tracks the performance of 30 major publicly traded firms listed on U.S. stock exchanges, mainly the Nasdaq and the New York Stock Exchange (NYSE). It was developed by Charles Dow and Edward Jones in 1896 and is an essential indicator of the state of the American economy and stock market. Because DJIA is price-weighted, firms with higher stock prices significantly impact how the index moves. Investors and analysts frequently use it as a benchmark to assess market trends and the economic state, even though it does not accurately reflect the entire market like more comprehensive indices like the S&P 500. Given the sizeable impact that (DJIA) companies have on the American economy, it is imperative to look into CEO compensation within these companies. The DJIA comprises 30 companies whose pay practices often set industry standards and impact trends beyond their respective industries. These businesses are crucial in setting standards for compensation practices in the corporate sector because of their size, market value, and economic clout. As a result, knowing their CEO compensation plans provides information about executive

incentive schemes, corporate governance trends more generally, and how these affect shareholder value.

Recent analyses reveal that CEO pay has experienced substantial growth; for instance, in 2023, chief executives earned 290 times the salary of an average worker, a significant increase compared to 1965, when their compensation was 21 times that of the average worker (Bivens et al., 2024). This significant increase draws attention to the expanding pay gap between executives and employees, which feeds into broader debates about wealth distribution and economic inequality. Because of their power, CEO compensation in DJIA businesses frequently attracts public and regulatory attention. Looking at these pay structures, one can establish if rising executive wages are due to poor board supervision and managerial power or performance.

The effectiveness of performance-based compensation plans and income inequality are called into doubt by this growing pay gap. It forces a more thorough analysis of whether current CEO incentives support the production of shareholder value or if they promote short-term choices at the price of long-term expansion. The growing pay gap between CEOs and typical workers raises concerns about employee morale, productivity, and social cohesion. Policymakers and stakeholders can better understand the broader implications of executive pay practices and determine if they cause or worsen economic inequality by looking into these issues inside DJIA companies.

Furthermore, knowledge of the dynamics of CEO pay in these significant corporations can help guide corporate governance changes and policy choices that promote fair and long-term economic growth. Insights from DJIA companies can guide regulatory frameworks, such as pay ratio disclosures, shareholder voting on executive compensation ("say on pay"), and the implementation of long-term incentive plans tied to environmental, social, and governance (ESG) outcomes. Additionally, examining the compensation practices of these leading corporations can evaluate the effectiveness of recent reforms and identify areas that still need action to ensure responsibility, equity, and value creation. The relationship between compensation and firm performance will also be strengthened by looking at the CEO compensation plans of DJIA companies. Evaluating the effectiveness of existing pay models

requires knowing whether high compensation packages are associated with better financial outcomes, innovation, and long-term shareholder value. It also sheds light on how executive behaviors such as risk-taking, investment choices, and business strategy are influenced by compensation incentives.

Thus, given their significant impact on public policy, corporate governance norms, and economic trends, it is imperative to examine CEO compensation in DJIA companies. By tackling significant issues like CEO accountability, income inequality, and pay-performance alignment, the knowledge gained from these studies can promote more sustainable and equitable business practices.

## 2.3. Previous Research.

A thorough and in-depth analysis of the relationship between executive compensation and firm performance, size, governance, and environmental factors can be found in the literature on CEO pay. It represents a range of approaches, eras, and business environments. A recurring theme in these studies is the tension between paying CEOs to behave in the best interests of shareholders and the practical challenges of actually tying pay to performance indicators. This section focuses on the factors that affect CEO compensation, emphasizing the firm's size and performance. The previous empirical evidence (Lambert & Larcker, 1987; Jensen & Murphy, 1990; Baber et al., 1998; Murphy, 1999; Leone & Zimmerman, 2006; Gong, 2011) illustrates that accounting metrics and the earnings specifically reported play a constituent role in CEO pay, most of all in setting the CEO's pay in total and cash pay. Total CEO compensation is positively and significantly related to firm efficiency; while CEO cash compensation is linked to revenue efficiency, incentive compensation is linked to cost efficiency (Sun et al., 2013). Sun and Cahan (2009) argue that if the firm has a high-quality compensation committee, then CEO cash compensation is more highly related to accounting earnings, and the majority of the Fortune magazine performance metrics had no effect on CEO compensation. That is, CEO pay was not connected to the majority of performance measures! Which is surprising considering the research. On the other hand, several earlier research studies have employed market-based measures to evaluate firm performance (Conyon & Murphy, 2000; Ozkan, 2011). They argue that the use of stock return and Tobin's Q significantly influences CEO compensation. In addition to this, Ueng et al. (2000)

illustrated that the size of a firm is the most significant determinant of CEO compensation for the firms. According to the evidence of this study, CEO compensation in large firms is mostly influenced by the power of the CEO over the board of directors, firm size, and firm performance. The result of Callan and Thomas (2012) shows that firm size is a significant determinant of compensation. Jensen and Murphy (1990) consider CEO pay and firm performance to establish whether executive compensation is established in shareholders' interests. Scholars studied U.S. firm data from 1980 through 1994, focusing on pay-performance sensitivity, or the extent to which CEO compensation changes are linked to firm performance indicators such as stock returns and profitability. The use of regression analysis in the research established a weak positive correlation between firm performance and CEO pay, in that higher performance is associated with higher CEO pay. The results also reveal higher pay performance in companies with better corporate governance mechanisms. The study concludes that although CEO pay responds to performance, the sensitivity is low and indicates that there is room to improve the alignment of executive incentives with shareholder value. Prescriptions include the utilization of performance-contingent compensation schemes to improve this alignment and firm performance. Core et al. (1999) examine the role that corporate governance mechanisms play in the CEO pay-firm performance relationship. Using the panel data of Fortune 500 firms for 1990-2000, researchers examined the impact of equity-based compensation, including stock options, on firm performance measured by profitability and shareholders' returns. Equity-based compensation and firm performance are significantly and positively correlated by different regression models, especially in industries with great development potential. The results highlight how equity-based compensation effectively aligns the CEO's interests and those of the shareholders, strengthening financial performance. According to the study, the inclusion of equity-based compensation in CEO pay packages enhances business success in compliance with good governance practices. It suggests firms implement customized compensation packages that are attuned to industry environments and strategic objectives. Aggarwal and Samwick (1999) investigate the role of industry environment and strategic competition in the sensitivity of CEO pay to firm success. Between 1987 and 2005, the study used 2,000 public companies to examine the influence of industry competition on pay-performance sensitivities. As competition increases accountability and efficiency demands, the study used econometric specifications to conclude

that CEO compensation is more associated with firm performance in competitive industries. The results also showed the need for relative performance evaluation, in which CEOs are compensated for performing better than others. The paper concludes that competitive pressure strengthens the link between CEO pay and performance, and that industry circumstances are key to determining effective compensation practices. In order to align the CEO's interests with shareholders' long-term value, the paper recommends that companies in less competitive industries employ greater performance-related pay. Murphy (1999) offers a comprehensive review of empirical studies on executive compensation with special reference to the relationship between CEO compensation and firm performance. The study addresses cash compensation, bonuses, stock options, and long-term incentives by pooling data from other studies covering the period 1980-1995. The study uses meta-analysis methods to report pay-performance sensitivity, which is relatively modest. The findings emphasize the significance of equity-based compensation in enhancing CEO-shareholder alignment. Companies with more independent boards are more pay-performance sensitive. The article highlights how governance mechanisms can affect this relationship. The recommendations are to improve governance processes and redesign compensation plans to meet industry and firm expectations. Mehran (1995) explain how variations in compensation plans affect firm performance, highlighting the role of equity incentives. Using a sample of manufacturing firms from 1980 to 1990, researchers conducted a regression test to examine the relationship between stock-based compensation and return on assets. The findings showed that equity-based compensation played an important role in improving business performance, especially in companies with growth opportunities. According to the findings of the study, CEO compensation plans that include stock options and performance shares better reflect the interests of shareholders and produce superior financial performance. It recommends that firms blend cash and equity incentives to optimize performance alongside risk management.

Frydman and Jenter (2010) study the long-run trends of CEO compensation and their effects on firm performance from 1936-2005. Researchers utilized archival data for publicly traded U.S. firms, following how the compensation plans developed, including salary, bonuses, stock options, and equity grants. Using econometric analysis, the study detected a significant increase in equity-based compensation associated with improved firm performance. The findings suggest that the shift to equity-based compensation enhanced the

alignment of CEO incentives with shareholder value. The study concludes that while equity-based compensation has had a positive impact on firm performance, its overuse can foster risk-taking behavior. The recommendations suggest a balanced design approach to compensation that welcomes fixed and performance-based components. Coles et al. (2006) examine how risk-taking, managerial incentives, and firm performance are related. By using regression analysis, researchers analyzed a sample of S&P 1500 firms from 1992 to 2003 to determine the influence of equity-based compensation on risk-taking behavior and firm outcomes. The results showed that CEOs with more equity-based compensation were likely to take strategic risks, thereby increasing performance for high-growth industries. But the study also pointed out possible disadvantages, including higher return volatility. The study concludes that equity-based compensation can improve firm performance if it is designed with respect to the firm's risk profile and industry environment. It suggests carefully calibrating incentive plans to balance risk and return. Tosi et al. (2000) use a meta-analysis to evaluate the relationship between CEO pay and firm performance in 137 empirical studies published between 1970 and 1999. Researchers focused on firm performance measures such as profitability, stock returns, and growth rates in analyzing compensation plans, which included base pay, bonuses, and equity-based pay. The findings reflected a statistically significant yet weak positive relationship between pay and performance, with equity-based pay having the strongest relationship. The paper concludes that while performance does influence CEO pay, other factors, such as firm size and industry norms, play a more significant part. It recommends improving the design of the incentive plans with a view to strengthening the pay-performance relationship. Fahlenbrach and Stulz (2011) explain CEO pay incentives in relation to the 2008 financial crisis. Using a sample of 98 U.S. banks, researchers examined the relationship between equity-based compensation and risk-taking behavior before the crisis. The study that used logistic regression models shows that banks with more equity-based pay have performed worse during the crisis because their CEOs used risky strategies. According to the study, equity-based incentives can create diverging interests under certain situations, and hence it is essential to have risk-aware compensation plans. It recommends incorporating long-term performance metrics and clawback provisions in compensation contracts. Gabaix and Landier (2008) analyze the sharp rise in CEO compensation since the 1980s and its implications for firm performance. Scientists used a

theoretical model and data on large U.S. firms for the period 1980-2003 to analyze the interplay between firm size, CEO quality, and pay. The analysis revealed that firm size growth accounted for the majority of increasing CEO compensation, as larger firms provided higher compensation to obtain the best CEOs. The paper concludes that the increase in CEO pay mirrors the market-driven force and not inefficiencies and that firm performance is improved by appointing talented executives. It suggests that boards should closely consider market conditions in determining CEO compensation.

Kaplan (2013) analyzes the connection between CEO pay and shareholder value creation in the last three decades. Using longitudinal data from S&P 500 firms, the study analyzed compensation plans, including bonuses and stock options, against firm performance metrics like total shareholder return (TSR). The study demonstrated that shareholder value and equity-based pay were positively correlated, with CEOs at high-performing companies being better paid. The study warns against excessive use of stock options but concludes that performance-based compensation plans effectively align CEO incentives with shareholder interests. It recommends balancing equity incentives with other forms of compensation to limit risk-taking behavior.

Hall and Liebman (1998) consider whether CEO compensation is structured to link with firm performance or resemble more fixed bureaucratic pay. Using data from publicly traded U.S. firms for the period 1980-1994, researchers tested the sensitivity of CEO wealth to changes in firm value, focusing on equity-based incentives. Regression analysis found CEOs to be highly motivated by stock ownership, with CEO wealth increasing significantly with firm performance. CEO pay is performance-driven rather than bureaucratic, the research concludes, so equity-based compensation is effective in aligning interests. It suggests increasing stock-based compensation to achieve even greater alignment. Rosen (1982) examines the relation between earnings distribution and hierarchical structures, namely the influence of firm size on executive compensation. According to the study, larger companies' complicated hierarchies demand more capable leaders, which warrants higher pay scales. According to the theory, the marginal product of executive ability increases with firm growth, and as a result, there is a disproportionate increase in CEO compensation compared to lower-level workers. The study supports the argument that firm size is an important factor in

executive compensation, which illustrates that large firms pay much more in order to obtain and retain the most capable managerial talent. The study reaches a conclusion that the value of managerial ability is multiplied in large firms due to the scalability of executive decisions, which increases compensation. It proposes that compensation committees consider firm size as a determining factor when designing executive compensation packages to be competitive in the job market. Ning et al. (2024) studied the historical development of CEO pay arrangements and how this development affects the link between CEO pay and firm performance. Using information about U.S. companies from 1949 through 2020, the authors found that stock options, which became more prevalent in the 1980s, increased CEO pay and had a greater random impact on it. Later additional regulations and increased utilization of stock awards helped bring this effect down. The study shows how CEOs' pay shapes whether their pay is tied to their performance. It suggests companies update compensation plans to reflect new regulations and market trends.

Conversely, several researchers explored the relationship between CEO compensation and firm size. Baker et al. (1988) talk about the alignment between theoretical compensation models and actual corporate practice, focusing on the effect of firm size on CEO pay. The authors examine data from a sizable number of corporations and discover that, although there are incentive-based determinants, firm size accounts for much of CEO compensation. Larger corporations, the study determines, have a higher base salary and bonus irrespective of performance measurements, with implications of size-related responsibilities and complexity requiring more compensation. The authors find that business size frequently overlooks performance-based incentives in compensation decisions. The authors suggest that firms analyze their compensation packages to provide a balance between size-based compensation and performance-based pay so that the incentives encourage the CEOs towards the growth of the company's value. For quantifying the impact of business size changes on CEO compensation, Kostiuk (1990) empirically analyzes the impact of firm size on executive compensation. The article uses regression analysis to examine the elasticity of CEO compensation to firm size, proxied by sales and assets, using cross-sectional data for a group of companies. With compensation elasticity estimates ranging from 0.25 to 0.35, the results document a positive and significant relation that indicates a 10% increase in firm size is equal to a 2.5% to 3.5% increase in CEO pay. CEO compensation, the study concludes, is greatly

influenced by firm size, possibly due to the greater responsibility and complexity that comes with leading larger firms. To make executive compensation more attuned to organizational requirements and shareholder interests, it recommends that boards take into account firm size and performance metrics. Frydman and Saks (2010) examine the long-run patterns of executive compensation, highlighting the role played by firm size and performance in driving CEO pay from 1936 to 2005. Using a new data set of publicly traded U.S. firms, the authors investigate the ways in which changes in firm size and economic conditions have influenced CEO compensation over the last seven decades. According to the study, CEO compensation has always been influenced considerably by the firm size; larger companies pay more because they have greater responsibilities and need for managerial talent. Further, according to the study, the elasticity of CEO compensation with respect to firm size has increased in the recent past decades in accordance with the evolution of market conditions and also in corporate governance practice. The authors suggest that firm size significantly impacts CEO compensation and that future research examine the impact of governance, performance, and firm size together on executive compensation. Gabaix and Landier (2013) revisit CEO compensation and firm size, this time in context with the financial crisis of 2008.Based on 2004-2011 data, the authors examine the change in firm value and its influence on CEO compensation. From their research, they determine that CEO compensation is positively related to firm size, but the financial crisis created complexities that impacted this relation. In particular, the relative drop in CEO compensation was not always commensurate with periods of large negative shocks to company size, reflecting possible biases in the pay-size relationship. The paper concludes that exogenous economic shocks have the potential to destabilize the usual positive correlation between firm growth and CEO pay, and thus calls for flexible compensation plans that take into account the volatility in the economy.

Ozkan (2011) focuses on the determinants of CEO pay in the UK, paying particular attention to firm size and performance. The article uses panel data on UK companies to examine the impact of a range of characteristics, such as firm size, on CEO pay. The results show that although CEO pay is in most cases positively affected by firm size, in some cases the effect is less clear or even negative, especially in smaller companies or those with specialized governance structures. There are a few instances in which a larger firm does not always equal more CEO compensation, namely when performance measures do not warrant

size increases, the study says. The study concludes that examining the pay-size relation requires a comprehensive approach that takes into account factors like market conditions, governance, and firm performance. Furthermore, the application of geometry to CEO compensation and benchmarking does not exist. Some papers use Riemannian geometry, e.g., He (2009) models a continuous-time principal-agent problem where the firm size evolves as a geometric Brownian motion and the executive influences its drift through effort. Using a stochastic control methodology, the paper constructs an optimal contract, balancing incentive provision and risk-sharing. The firm size dynamics are explained through a stochastic differential equation with the drift governed by the CEO's effort level, and compensation must be crafted to induce continuous exertion. The article applies the Martingale Representation Theorem to express the agent's continuation payoff in terms of firm performance. The Hamilton-Jacobi-Bellman (HJB) equation is applied in deriving the optimum contract that is incentive compatible at the lowest cost. The framework uses vector functions and convex geometry to study the dynamic evolution of the CEO's pay, solving for valuable constraints such as limited liability and liquidation constraints. The results highlight that performance-contingent stock grants are the best incentives, particularly in firms where agency problems are acute due to size considerations. This approach provides a strong platform to analyze executive compensation plans in dynamic, uncertain environments.

Finally, Table No. (2.1) summarizes the previous research and classifies them according to firm size and performance as CEO compensation predictors.

Table No. (2.1): Previous Research Summary

| Study | Firm Size as a Predictor | Firm Performance as a Predictor | Key Findings |
|---|---|---|---|
| Lambert & Larcker (1987). | No | Yes | Financial measures influence CEO compensation. |
| Jensen & Murphy (1990). | No | Yes | Positive but modest link between CEO pay and firm performance. |
| Baber et al. (1998). | No | Yes | Earnings significantly impact CEO cash compensation. |
| Murphy (1999). | No | Yes | A review of research finds weak pay-performance sensitivity. |
| Leone & Zimmerman (2006). | No | Yes | CEO pay linked to firm efficiency. |
| Gong (2011). | No | Yes | CEO cash compensation is linked to earnings; incentives are linked to cost efficiency. |
| Sun & Cahan (2009). | No | Yes | CEO pay is not significantly related to most Fortune performance indicators. |
| Conyon & Murphy (2000). | No | Yes | Stock returns and Tobins Q determine CEO pay. |
| Ozkan (2011). | No | Yes | Firm performance influences CEO compensation in the UK. |
| Ueng et al.. (2000). | Yes | No | Firm size is the most critical determinant of CEO compensation. |
| Callan & Thomas (2012). | Yes | No | Firm size significantly determines CEO compensation. |
| Sun & Cahan (2013). | Yes | No | Negative relationship between compensation committee quality and firm size. |
| Core et al. (1999). | No | Yes | Equity-based pay aligns CEO interests with shareholders. |
| Aggarwal & Samwick (1999). | No | Yes | Competitive industries have more substantial pay-performance alignment. |
| Mehran (1995). | No | Yes | Equity-based pay improves firm performance. |
| Frydman & Jenter (2010). | No | Yes | Equity-based pay increase improved firm performance. |
| Coles et al. (2006). | No | Yes | Equity-based pay increases risk-taking. |
| Tosi et al. (2000). | No | Yes | Weak link between pay and performance, firm size matters more. |
| Fahlenbrach & Stulz (2011). | No | Yes | Equity pay led to excessive risk-taking during the financial crisis. |
| Gabaix & Landier (2008). | Yes | No | Firm size drives CEO pay growth. |
| Kaplan (2013). | No | Yes | Performance-based pay aligns CEO interests with shareholders. |
| Hall & Liebman (1998). | Yes | No | CEO wealth is closely tied to stock-based compensation. |
| Rosen (1982). | Yes | No | Firm size justifies higher CEO pay. |
| Baker et al. (1988). | Yes | No | Firm size dominates compensation decisions over performance. |
| Kostiuk (1990). | Yes | No | Firm size significantly affects CEO pay. |
| Frydman & Saks (2010). | Yes | No | Firm size has influenced CEO pay historically. |

| | | | |
|---|---|---|---|
| Gabaix & Landier (2013). | Yes | No | The financial crisis disrupted the size-pay relationship. |
| Ning et al. (2024). | NO | Yes | Mathematical model linking firm size to CEO pay dynamics. |

Previous classifications have set that previous studies on CEO compensation were largely within two categories: the first that employs company performance as the primary explanatory variable while controlling for firm size and the second that employs firm size without completely accounting for firm performance. Although others attempt to capture both at the same time, their findings also reveal that firm size or performance is largely dominant in determining CEO compensation. This shows the presence of research gap because few studies examine together the impact of both variables as key explanatory drivers. There has to be an improved method that seeks to know more about the way combined effects of interaction between firm performance and firm size separately affect the CEO compensation structure, leading to a more complete and representative picture of executive pay. However, most of the previous research has utilized statistical and econometric models to achieve research objectives. The Lake studies suggest using geometry to CEO benchmarking. This article tries for the first time to use the angle measurement between 3D vectors as a tool in solid geometry to connect CEO compensation with firm size and performance.

In summary, amid frequent arguments regarding whether executive compensation should be tied to firm size and performance, CEO pay analysis is still a critical aspect of business governance. Although this relationship has been heavily explored using economic and statistical frameworks, in this study, an unconventional methodology was used where principles of solid geometry were utilized to normalize CEO pay. This system offers a new mathematical method of correlating executive pay with firm size and performance through three-dimensional vector analysis and angular measurement. This geometric approach offers a more systematic way to compare CEO effectiveness across firms, increases transparency, and improves the accuracy of benchmarking. A more fact-based and impartial compensation framework is ultimately developed by combining solid geometry with executive compensation analysis, such that CEO compensation is aligned with firm performance. Figure 2.1 summarizes the literature review and the gap.

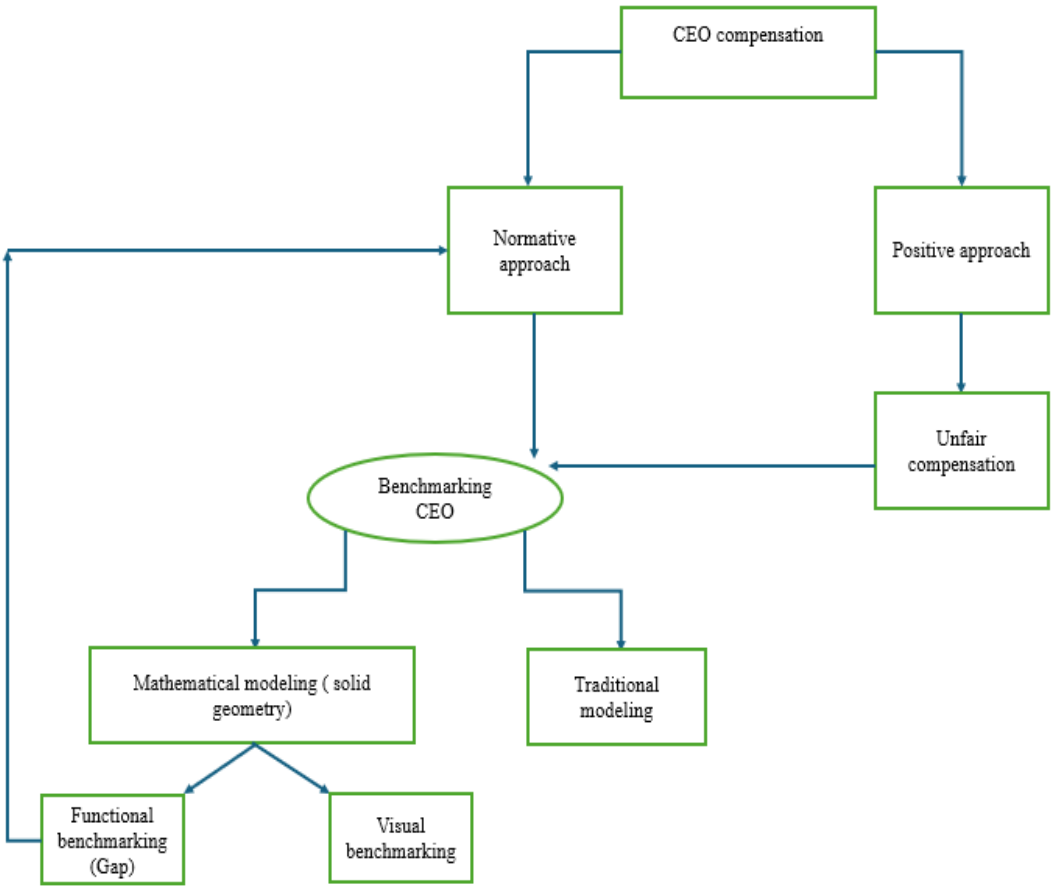


Figure No. (2.1): Literature Review Gap

as shown in Figure No. (2.1) The model shows a diagrammatic representation of examining CEO pay using normative (ideal) and positive (real-world) methods. The positive method leads to unfair pay, while the normative method tries to establish sensible pay by benchmarking. Benchmarking can be done using traditional or mathematical modeling (solid geometry), like functional and visual benchmarking (gap analysis). This step helps to compare CEO pay to industry benchmarks in order to identify misalignments. The model also suggests a feedback loop, where benchmarking on a regular basis informs and defines CEO pay, rendering it equitable and preventing excessive pay.

Finally, after reviewing the literature and the previous research, benchmarking CEOs needs to determine the CEO's efficiency by an objective index; this index should capture the main three determinants of CEO efficiency (firm performance, size, and CEO compensation). Accordingly, this research tests the following hypotheses based on the procedural definition

of the efficient CEO who can exploit the minimum economic resources to generate higher economic benefits and, in turn, receive lower total compensation:

$(\boldsymbol{H1})$**:** The CEO efficiency index is determined by maximizing firm performance.

$(\boldsymbol{H2})$**:** The CEO efficiency index is determined by minimizing firm size.

$(\boldsymbol{H3})$**:** The CEO efficiency index is determined by minimizing CEO compensation.

After proving that the derived index is valid to express CEO efficiency, the study can then adjust the CEO compensation to the desired (normative compensation) using the index equation. However, the study tests the following hypotheses to confirm the consistency of the adjusted compensation with the normative perspective.

$(\boldsymbol{H4})$**:** Firm performance is more significant in explaining the adjusted CEO compensation than the actual CEO compensation.

$(\boldsymbol{H5})$**:** Firm size is more significant in explaining the adjusted CEO compensation than the actual CEO compensation.

# 3. Chapter Three: Methodology

## 3.1. Introduction

Based on the theories and evidence discussed in the literature review, the study will take into account the following critical points while structuring the method:

- Following the peer group comparison model suggests selecting the sample based on size, industry, and geographic scope (Bizjak et al., 2008). The firm size is an explanatory factor in the model, and the sample depends on the sector.
- Firm performance is an explanatory factor in the model, which agrees with the performance-based benchmarking model (Bebchuk & Fried, 2004).
- The method adjusts the CEO's compensation, consistent with the relative performance evaluation model (Faulkender & Yang, 2010).
- The derived equation in this study allows the users to choose the appropriate benchmark, whether from market median benchmarking as suggested by Gabaix and Landier (2008) or the upper/down tail of peers' firms.
- The central assumption of this study is to define the efficient CEO as the CEO who can exploit the minimum economic resources to generate higher economic benefits and, in turn, receive lower total compensation. This assumption is consistent with Oberholzer (2016).
- Expand the analysis of (He, 2009) by highlighting the angles between 3D vectors. While He (2009) uses Reinman geometry, this study uses solid geometry to achieve the study objective.

## 3.2. Conceptual model

However, the model's idea is based on the theoretical linking between trigonometric functions in three-dimensional space and compensation literature. Firm size, firm performance, and total CEO compensation are the needed variables to derive the model. The model provides a solution for selecting the benchmark CEO among the peer firms and also answers the question of the potential metrics of CEO compensation explanatory factors (firm performance and size that should be achieved by comparing the benchmark firm and peer

firms); that is why this research depends on the normative approach. The following steps explain the model procedures and illustrate the method for policymakers and users.

**phase one: Choosing peer firms**. When evaluating CEO compensation, policymakers frequently implement the benchmark of CEOs in the same industry because it guarantees comparability and fairness, especially since industry-specific risks, barriers, and performance requirements can have significant effects on executive responsibilities and results. Employing sector-based benchmarks helps businesses better to match pay packages to competitive practices and market norms, preventing excessive pay that could result from inaccurate comparisons across various industries with differing levels of complexity. Moreover, this approach supports retaining top executive talent by offering competitive compensation that reflects industry-specific standards and shareholder expectations (Murphy, 2013). However, the study argues the data collection process later on in this chapter.

**Phase two: Determining the needed factors**. As discussed in the literature review, firm size, performance, and CEO pay are the needed factors to employ the model; Policymakers often use firm size, firm performance, and CEO pay as key indicators to assess CEO compensation because these factors are closely linked to corporate success and shareholder value. The size of the company, as indicated by its market capitalization or total assets, reflects the complexity and breadth of its activities, which may call for a higher CEO salary. Metrics like earnings per share or return on assets are commonly used to evaluate firm performance, which demonstrates how well the CEO can propel the company's growth and profitability. When compensation is linked to performance, it promotes value creation and aligns the interests of CEOs and shareholders. Jensen and Murphy (1990) assert that by comparing CEO compensation to company size and performance, policymakers can identify excessive compensation practices and ensure equity and accountability in corporate governance. However, the study argues on the measurement of variables later in this chapter.

**Phase three: Apply the solid geometry:** Representing firm size, firm performance, and CEO pay in a 3D space offers a clear visual framework to assess CEO efficiency by comparing their compensation against company outcomes relative to scale. This multidimensional approach allows for studying the relationship between selected factors and

investigating the geometric functions between each other. Direct comparisons across firms, highlighting whether higher pay aligns with superior performance when accounting for firm size. As clusters and outliers become more apparent, it becomes easier to identify CEOs who are overpaid or underpaid in relation to the performance of their company. Additionally, as will be shown later in this chapter, this modeling makes benchmarking more effective and enables stakeholders to evaluate pay-for-performance alignment across different companies.

**Phase four: Choosing the benchmark.** Policymakers decide their benchmark firm to compare with. Using the equation illustrated later in this chapter.

**Phase five: Calculate the adjusted compensation.** Policymakers can use the mathematical model to adjust the CEO's compensation relatively to the benchmark to pressure the CEO contract to maximize efficiency.

**Phase six: Validate the results**. This part of the analysis serves the research purposes, as Chapter four explains.

However, the following figure summarizes the method phases.

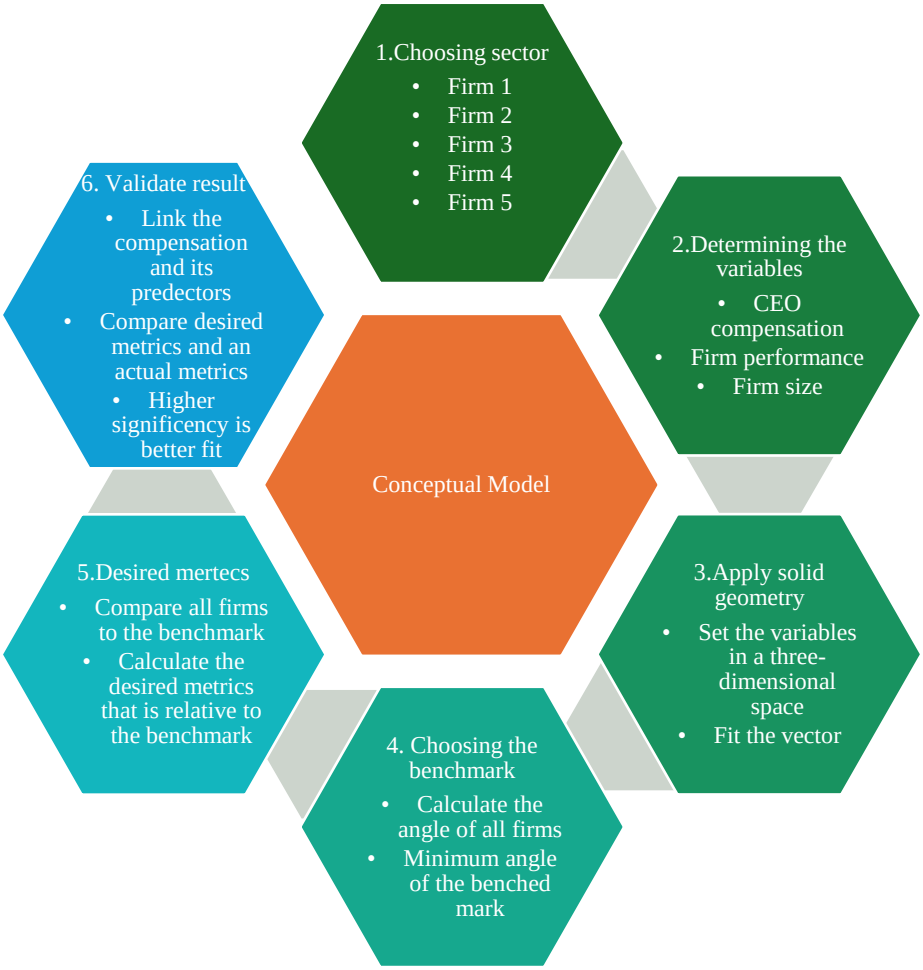


Figure No. (3.1): Conceptual Model

The study claims that the model applies to any sector in any market; after proving the model's validity in any case, the equations can be generalized. After applying the method to the markets, the boards can judge their CEOs and amend the contracts relative to the benchmark. As the years pass, CEO compensations will automatically correct relative to the benchmark, leading to higher competition between them to be the benchmark for the entire market. Thus, over time, CEO compensation will get closer and closer to the normative

theory. The following sections contain more illustrations of solid geometry and its uses in the issue.

### 3.3. Deriving the Equation.

The following derivation depends on the three-dimensional vector principles as illustrated in Calculus 3 (Strang et al., 2016):

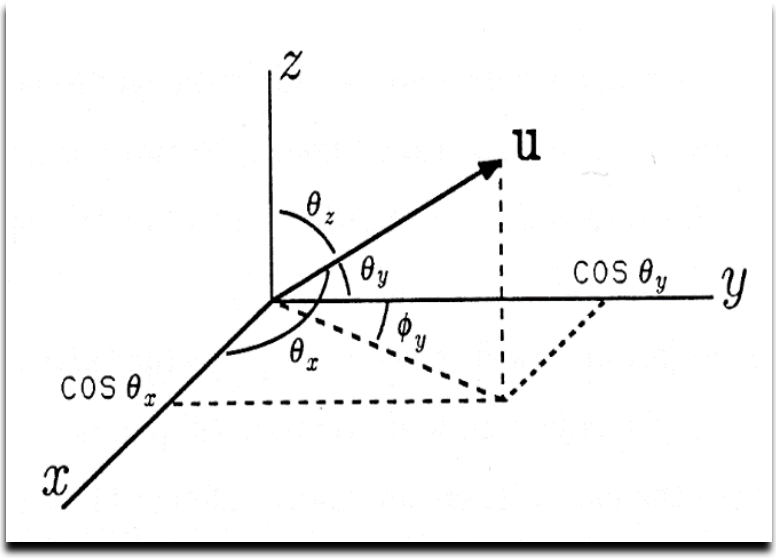


Figure No. (3.2): Vector in 3D

Figure No. (3.2) shows the resulting vector of intersection point of CEO compensation, total assets, and net profit in a three-dimensional space.

Where:

The dimension “Z” = firm performance at the end of the financial period.

The dimension “X” = total CEO compensation at the end of the financial period.

The dimension “Y” = firm size at the end of the financial period.

Vector “U” = results from the intersection point of X, Y, and Z in three-dimensional space.

According to the rational argument of the previous literature, the most efficient CEO is the CEO who achieves the highest performance, conditional on minimal compensation and firm size. By imagining the previous figure, it is noticed that this condition is fulfilled only when the vector “U” is as close as possible to the Z-axis(performance-axis); in other words,

the CEO efficiency is maximized if the angle θz is minimized. According to the trigonometric functions in three-dimensional space, the following equation measures this angle:

$$\boldsymbol{\theta^{\circ} = cos^{-1}\left(\frac{performance_{\tau}}{\sqrt{(performance_{\tau})^2+(size)^2+(Compensation_{\tau})^2}}\right)} \qquad \textbf{(1)}$$

Where:

$\theta^{\circ}$: an index of the CEO's efficiency who received total compensation (C) via operating available resources (firm size) for achieving performance during the financial period ($\tau$). Actually, $\theta^{\circ}$ is a measurement of the angle between the vector (which results from the intersection point of X, Z, and Y in three-dimensional space) and the performance axis.

### 3.4. Data:

In empirical research, cross-sectional data is the most common data set to investigate the relationship between CEO compensation, firm size, and firm performance. This method enables researchers to examine differences among companies simultaneously, providing information on how various factors impact executive compensation. Riahi and Pavlik (1993) employed cross-sectional data from 216 Fortune 500 firms, demonstrating that firm size and ownership structure significantly impact CEO compensation, mediated by firm performance. Similarly, Sigler & Haley (1995) used cross-sectional data to show a positive relationship between CEO pay and performance, suggesting that compensation mechanisms align CEO and shareholder interests. These studies demonstrate how well cross-sectional data can identify trends and connections in CEO compensation across a range of firm characteristics.

Additionally, CEO benchmarking ensures that CEO compensation stays competitive and consistent with industry norms by requiring decision-makers to evaluate CEO efficiency and compensation against peer companies in the same sector annually. In order to determine if a CEO is underperforming or receiving excessive compensation concerning their peers, these comparisons are essential. Furthermore, because it examines several companies at one time to identify trends and variances throughout the sector, this benchmarking strategy is consistent with using cross-sectional data. Decision-makers can make more unbiased and data-driven executive pay decisions using cross-sectional analysis that provides an understanding of current performance criteria and compensation designs.

However, the Dow Jones market includes only 30 firms, which results in a small sample size that is insufficient for conducting an Ordinary Least Squares (OLS) regression model to ensure the validity and reliability of the estimated equation. A small sample size can reduce statistical power, increase standard errors, and compromise the robustness of the results. The analysis uses panel data on DOW Jones firms from 2019 to 2023 to increase the sample size to overcome this issue. By combining observations from different companies across several years, panel data increases the sample size and improves the findings' generalizability. It is important to mention that the study does not concern a time dimension, examine firm-specific impacts, or follow changes over time within individual firms. It ensures that the research stays focused on the data as independent observations, not continuous trends, by concentrating only on cross-sectional fluctuations among firms throughout the chosen years.

Therefore, and because of the controversial results in the Dow Jones case, the study will apply the model to 150 observations from the Dow Jones industrial sector Panel data during 2019- 2023.

Furthermore, according to Core et al. (1999), taking performance and size from the prior period ensures that the independent variables are not influenced by the dependent variable (CEO compensation). This strengthens the causal interpretation of the relationship. Also, CEO compensation packages are typically determined based on past performance and firm characteristics. For instance, a bonus or salary adjustment is often influenced by how well the firm performed in the previous year. In addition, using lagged variables helps avoid simultaneity bias, where CEO decisions might influence current firm performance or size. Thus, it is appropriate to use the company's size and performance from the prior fiscal year when calculating CEO compensation from the current one. The time lag in how such elements affect executive pay is reflected in this arrangement, which recognizes that CEO compensation decisions are frequently based on a firm's success and size in the previous quarter.

### 3.5. Validate the Equation:

To validate the results of the equation, the study conducts two approaches:

1. Conduct the following OLS regression model to ensure that the $\theta^{\circ}$ The index matches the theory of CEO efficiency. This study's central assumption is that the efficient CEO exploits the minimum economic resources to generate higher economic benefits and, in turn, receives lower total compensation. This assumption is consistent with Oberholzer (2016).

$$\boldsymbol{\theta^{\circ} = \alpha + B_1^{-} * Perf_{i(t-1)} + B_2^{+} * Size_{i(t-1)} + B_2^{+} * Comp_{it} + \varepsilon} \qquad \textbf{(2)}$$

Where:

$\boldsymbol{\theta^{\circ}}$**:** the index of CEO efficiency.

$\boldsymbol{Perf_{it-1}}$ **:** firm performance of firm i at year t-1.

$\boldsymbol{Size_{it-1}}$ **:** the size of firm i at yeat t.

$\boldsymbol{Comp_{it}}$ **:** CEO compensation of the firm i at year t.

**Note:** Key Properties of the Relationship between an angle θ (in degrees) and its cosine value (cos(θ):

Regardless of the angle, the Cos (θ) value lies between -1 and 1. $1 \leq \cos(\theta) \leq 1$.

Cos (0) =1 and cos (90) = 0.

At θ = 0, cos(θ) is at its maximum value of 1.

As θ increases from 0∘ to 90, cos (θ) decreases linearly to 0. That is why the sign of coefficients appears in model number (1).

Thus, the relationship between CEO efficiency and its indices will be as follows:

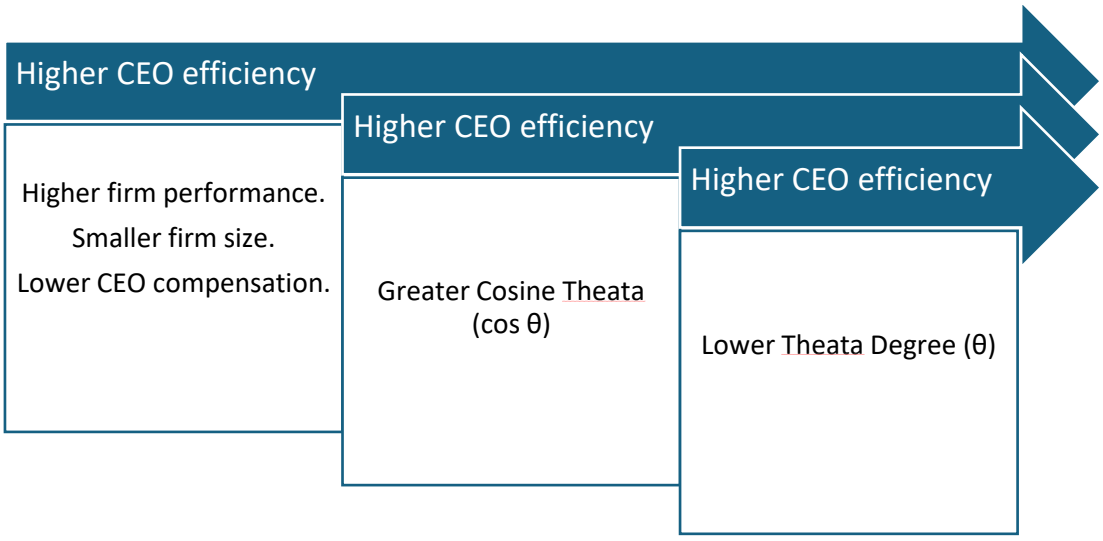


Figure No. (3.3): CEO Efficiency Indices

This means that both Theta Degree (θ) and Cosine Theta (cos θ) can be used to index CEO efficiency. It is important to match the regression model's underlying assumptions with the central assumption of CEO efficiency discussed in this study.

2. As discussed in the literature review section, the normative theory of CEO compensation argues that CEO compensation should be significantly and positively associated with firm performance and negatively and significantly associated with firm size. The following regression models compare the perimeter's results of the actual CEO compensation and explanatory factors on the one hand and adjusted metrics (as resulted from the Theta equation) with the explanatory factors on the other hand. Hence, if the perimeter of the adjusted metrics is more fit than the actual, the equation is valid and generalizable. In other words, the normative idea of CEO compensation argues that the compensation should be affected by firm size and performance. In this analysis, the study compares the explanation ability of the explanatory factors to both actual and adjusted metrics by conducting the following regression models on cross-sectional data of the targeted sector:

$$\boldsymbol{Comp_{it} = \alpha + B_1^{+} * Perf_{t-1} + B_2^{-} * Size_{t-1} + \varepsilon} \qquad \textit{(3)}$$

$$\boldsymbol{Adj.Comp_{it} = \alpha + B_1^{+} * Perf_{t-1} + B_2^{-} * Size_{t-1} + \varepsilon} \qquad \textit{(4)}$$

Where:

$\boldsymbol{Comp_{it}}$ **:** CEO compensation of the firm i at year t.

$\boldsymbol{Perf_{it-1}}$ **:** firm performance of firm i at year t-1.

$\boldsymbol{Size_{it-1}}$ **:** the size of firm i at yeat t-1.

$\boldsymbol{Adj.Comp_{it}}$ **:** the desired CEO compensation of the firm i at year t.

According to econometric guidance Studenmund (2014), R-squared measures the percentage of the variation of Y around its meaning that a particular regression equation has explained. Suppose the R square of the desired compensation is higher than the actual compensation. In that case, that means the explanatory factors can highly explain the desired compensation, and thus, it is closer to being normative, and the equation is valid.

### 3.6. Variables Measurement:

The purpose of the derived equation is to provide a method to measure an index of CEO efficiency and benchmark CEOs with each other. The concerned parties can choose the measurement tool following the firm and market circumstances. The case is highly similar to the issue of measuring the area of a triangle. The equation of the triangle area is constant, but there are several tools to measure the base length; an inch or a ruler are both usable.

However, traditional measures of firm size, such as the natural logarithm of total sales or assets, may fail to capture market-specific dynamics. This limitation could lead to misinterpretation of a firm's influence within its industry (Dang et al., 2018). As Dang et al. (2018) noted, selecting appropriate firm size measures is critical because different proxies can yield varying implications for empirical studies.

On the other hand, Buzzell et al. (1975) investigates the concept of market share as a measurement technique to express firm performance, in light of this seminal work and according to rational arguments, using market share as a metric to measure firm size, firm performance, and CEO compensation as a percentage of the market provides a more relative, context-specific, and competitive assessment compared to absolute financial figures. Due to their failure to consider market-specific characteristics, traditional metrics like total revenue, assets, or net income may not accurately reflect a company's competitive position within its industry (Buzzell et al., 1975). On the other hand, market share indicates how much the industry's metrics are under a company's control and directly reflect the company's influence within its sector. However, using market share to measure firm performance aligns with

strategic management theories, emphasizing competitive positioning as a key driver of financial success. Firms that capture a larger percentage of their market tend to experience higher profitability, innovation rates, and resilience against downturns, as supported by empirical findings from the Profit Impact of Market Strategies (PIMS) database (Buzzell et al., 1975). This approach is beneficial in sectors like technology, retail, and finance, where market share frequently determines long-term superiority, and absolute revenues may not be the best indicator of competitive strength. Furthermore, market share is a crucial indicator of future expansion and sustainability, which makes it a crucial instrument for assessing company performance in fast-paced sectors. Moreover, it is helpful to normalize CEO compensation concerning the firm's actual competitive influence rather than random financial statistics by calculating CEO pay as a percentage of overall market compensation. This strategy guarantees that CEO compensation aligns with absolute market dominance rather than the firm's size.

$$\boldsymbol{Comp_{i.t} = \frac{T.C_{i.t}}{\sum_{i=1}^{i=n} T.C_{i.t}}} \qquad \textbf{(4)}$$

**Where:**

$\boldsymbol{Comp_{it}}$ **:** CEO compensation of the firm i at year t.

$\boldsymbol{T.C_{i.t}}$ **:** Total CEO compensation of the firm i at year t.

$\boldsymbol{\sum_{i=1}^{i=n} T.C_{i.t}}$**:** The sum of total compensation for the sector in year t.

$$\boldsymbol{Size_{i.t} = \frac{T.A_{i.t}}{\sum_{i=1}^{i=n} T.A_{i.t}}} \qquad \textbf{(5)}$$

**Where:**

$\boldsymbol{Size_{i.t}}$ **:** The size of the firm i at year t.

$\boldsymbol{T.A_{i.t}}$ **:** Total assets of the firm i at year t.

$\boldsymbol{\sum_{i=1}^{i=n} T.A_{i.t}}$**:** The sum of total assets of the sector at year t.

$$\boldsymbol{Perf_{i.t} = \frac{EPS_{i.t}}{\sum_{i=1}^{i=n} EPS_{i.t}}} \qquad \textbf{(6)}$$

**Where:**

$\boldsymbol{Perf_{i.t}}$ **:** The performance of firm i at year t.

$\boldsymbol{EPS_{i.t}}$ **:** Earning per share of the firm i at year t.

$\boldsymbol{\sum_{i=1}^{i=n} EPS_{i.t}}$**:** The sum of earnings per share of the sector in year t.

$$\boldsymbol{\theta^{\circ} = cos^{-1}\left(\frac{Perf_{i.t-1}}{\sqrt{(Perf_{i.t-1})^2+(Size_{i.t-1})^2+(Comp_{i.t})^2}}\right)} \qquad \textbf{(7)}$$

**Where:**

$\boldsymbol{\theta^{\circ}}$**:** the index of CEO efficiency.

$\boldsymbol{Perf_{i.t-1}}$ : firm performance as measured by equation (6).

$\boldsymbol{Size_{i.t-1}}$ **:** firm size as measured by equation (5).

$\boldsymbol{(Comp_{i.t})}$**:** CEO compensation as measured by equation (4).

### 3.7. Robustness Analysis

To enrich the model and ensure the goodness of regression fit, the study will apply the following tests of regression's Classical Assumptions as illustrated in the practical guide of econometrics (Studenmund, 2014):

- The linearity of the regression
- The population means of the residuals should be zero.
- All the independent variables should not correlate with the residuals.
- The stationarity of the time series of residuals using the Dickey-Fuller test.
- Heteroskedasticity test.
- No perfect multicollinearity between the independent variables.
- The residuals should be normally distributed.

All these analyses help avoid spurious correlations on spurious R squares and enhance the goodness of model fit.

### 3.8. Methodological Constraints

The study aims to generalize the derived equation for worldwide markets, which needs to test the equation in an efficient market. According to Awad & Daraghma (2009), the Palestine Exchange (PEX) does not achieve the efficient market hypothesis at a weak level; the study chose DOW Jones firms to ensure the model's generalization. Furthermore, several

firms in PEX do not disclose the CEO's compensation as an independent item in the financial reports. However, the study applied the equation in a sample from PEX using executive management instead of CEO compensation to provide policymakers in PEX with illustrative examples and guidelines to use the derived equation.

Moreover, the insufficient number of companies in Dow Jones (only 30 companies) prevented the model from being applied to cross-sectional data and was replaced with panel data. However, the study treats the data set as independent observations with no significant impact on the regression results.

Furthermore, according to the measurement approach used in this study, to compete for the most efficient CEO, the company must achieve a net profit, not a loss; negative numbers result in performance without financial meaning for market share. Additionally, having a minus angle in three-dimensional space makes no sense and may lead to misleading results in regression analysis. However, in practice, no decision-maker is attracted to compare with the losing firm.

# 4. Chapter Four: Results and Analysis

## 4.1. Introduction

This chapter aims to present a thorough analysis of the CEO efficiency index, emphasizing how it has been validated using econometric and mathematical models. The main goal is to demonstrate how the obtained equation can be used to evaluate CEO efficiency and remuneration while methodically examining its accuracy and dependability. In order to do this, the study will examine and validate the index using econometric modeling approaches, ensuring that it offers a reliable and consistent indicator of executive efficiency. The key component of this validation process is testing all underlying assumptions that guide the use of the CEO efficiency index in a regression analysis. This ensures that the model satisfies the theoretical and statistical requirements for accurate and perceptive interpretation.

The chapter will also examine the relationship between the desired compensation that the calculated equation suggests and the actual CEO compensation. The study intends to investigate if existing CEO pay structures align with theoretical guidelines for performance and efficiency by thoroughly comparing these two metrics. Statistical tests and empirical evaluation will support this comparative analysis, highlighting any differences between the model's recommended compensation levels and the actual CEO compensation. These results will shed light on whether CEO compensation is appropriate given the size of the company and its financial success or if it is excessive or insufficient to ensure that the derived equation is theoretically sound and empirically verifiable. The final objective of this chapter is to develop a new, data-driven method of executive benchmarking that improves the efficiency, fairness, and transparency of CEO remuneration plans by thoroughly analyzing and implementing the CEO efficiency index.

## 4.2. Number of Observations Sufficiency.

According to Green (1991), 74 observations are sufficient to conduct a regression model with three independent variables and one dependent variable, based on the rule of thumb ($n \geq 50 + 8$ m). This ensures a reasonable level of power and accuracy in the regression analysis at a 95% confidence level. However, the study collects data from 30 firms in the DOW Jones from 2019 to 2023, which means that the gross sample size is 150 observations.

The study ignores seven observations because some net losses were achieved in several firms. Thus, the net sample size is 143 observations, which is more than sufficient.

### 4.3. Calculate Study Variables

Based on Buzzell et al.'s (1975) arguments of the preference for the market share approach, the appendices from 1 to 5 represent the study variables metrics illustrated in the previous chapter. They are sorted by financial period and arranged from the most efficient CEO to the least efficient CEO to facilitate the comparison and benchmarking process.

Where:

**Comp**..: total CEO compensation market share for the current financial period.

**Size**: market share of total assets for the previous financial period.

**Perf**.: market share of earnings per share for the previous financial period.

***θ*°Degree:** The CEO efficiency index measures the angle between the vector (which results from the intersection point of comp., size, and perf. in three-dimensional space) and the performance axis.

**cos *θ*°:** cosine of the angle of $\theta^{\circ}$Degree also considers an index of CEO efficiency.

As shown in the Appendices tables, consistent with the trigonometric function's laws, cos $\theta^{\circ}$ and $\theta^{\circ}$Degree is negatively and linearly correlated. The higher efficiency resulted from relative and simultaneously higher performance and the lowest both CEO compensation and size, which leads to an increase in cos $\theta^{\circ}$ and a decrease in $\theta^{\circ}$Degree concurrently. The results show that HD.N has the most efficient CEO for all financial periods since it achieves the lowest $\theta^{\circ}$Degree (24.52, 20.00, 15.58, 21.36,19.08), respectively.

The model user can choose the benchmark firm based on the firm's circumstances, the nature of the CEO's contract, or any other considerations with the concerned parties. Moreover, the user should pay attention to any accidental results; firm X may achieve the most efficient CEO at a specific financial period because of retained compensation and delaying CEO pay to future financial periods. However, HD.N is considered the benchmark firm in the DOW Jones case since its metrics were stable within the study period.

Figure (4.1) presents the intersection points of the DOW Jones' compensation, size, and performance in three-dimensional space during the study period.

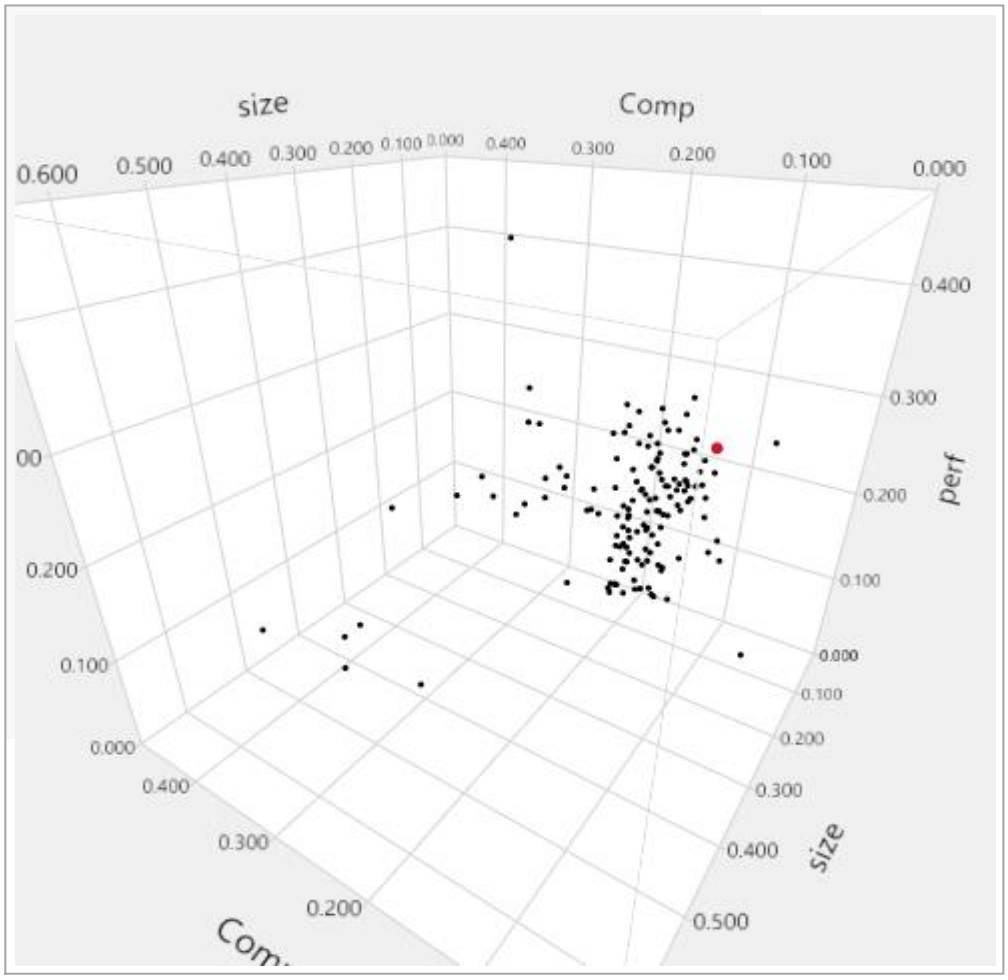


Figure No. (4.1): DOW Jones firms in 3D

The red point presents HD.N 2021; it generates the smallest $\theta^{\circ}$s degree between the performance axes and the resulting vector between (0,0,0) point and the market points, it is 15.58 degrees and 0.96 cosine theta. As shown in Figure 5, the market points look scattered. The study claims that the points act according to specific relationships and controls consistent with the theoretical concepts of CEO compensation. However, this claim needs evidence; the following analysis proves the idea.

### 4.4. Proving the Validity of CEO Efficiency Index.

The central assumption of this study is that the efficient CEO exploits the minimum assets to generate higher earnings and, in turn, receives lower total compensation. Hence, the

derived index should match the study's assumption. The study conducts the regression model in equation (2) to prove that.

### 4.4.1. Regression Linearity Test

Figure 4.2 shows how $\theta^{\circ}$Degree's act in a two-dimensional graph.

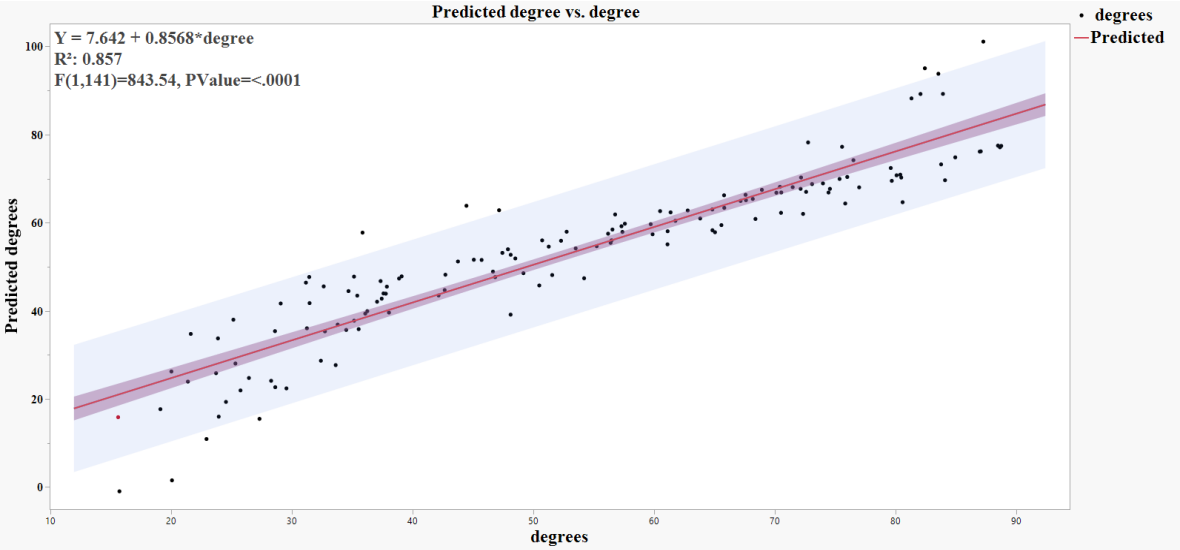


Figure No. (4.2): Linearity of $\boldsymbol{\theta}^{\circ}$Degrees

As shown in Figure (4.2), $\theta^{\circ}$Degrees constitute a linear function around the line of ( Y=7.642+0.856* $\theta^{\circ}$ Degrees), with 0.857 $R^2$ , and PValue of =<0.0001. That means $\theta^{\circ}$Degrees significantly explain 85% of predicted degrees resulting from the function above, according to Studenmund (2014). This proves the linearity of regression as an assumption of conducting the regression model. However, to enhance this result, the following analysis proves the underlying assumption of the OLS regression model.

### 4.4.2. Test of Normality Distribution

When assessing the normality of residuals in regression analysis, it is essential to consider both visual evidence and statistical tests to draw robust conclusions. Visual tools provide intuitive insights, while statistical tests offer formal evaluation. Combining these approaches ensures a comprehensive assessment.

- Visual Evidence:

Visual tools are often the first step in evaluating normality. A Q-Q plot (Quantile-Quantile plot) compares the quantiles of residuals to those of a theoretical normal distribution. Residuals aligning closely along the diagonal line suggest normality, while deviations (e.g., curvature or S-shapes) indicate skewness or kurtosis issues (Ghasemi & Zahediasl, 2012). Another helpful tool is the histogram of residuals, which should display a bell-shaped curve centered at zero if the residuals are normal. Systematic patterns in a residual vs. fitted values plot, such as a funnel shape, indicate non-normality or heteroscedasticity (Osborne & Waters, 2002). The following Figures (4.3) and (4.4) provide visual evidence of normally distributed residuals.

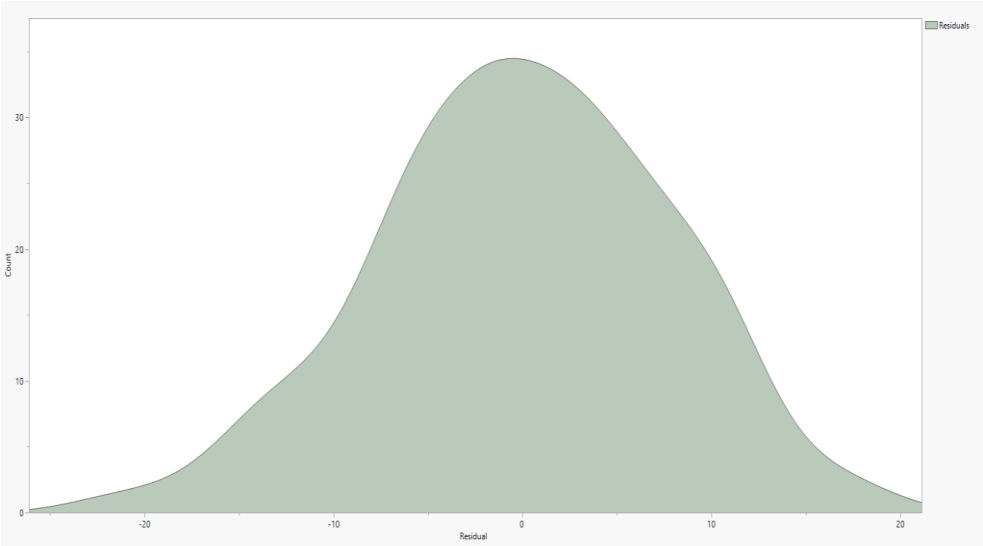


Figure No. (4.3): Normality of Residuals

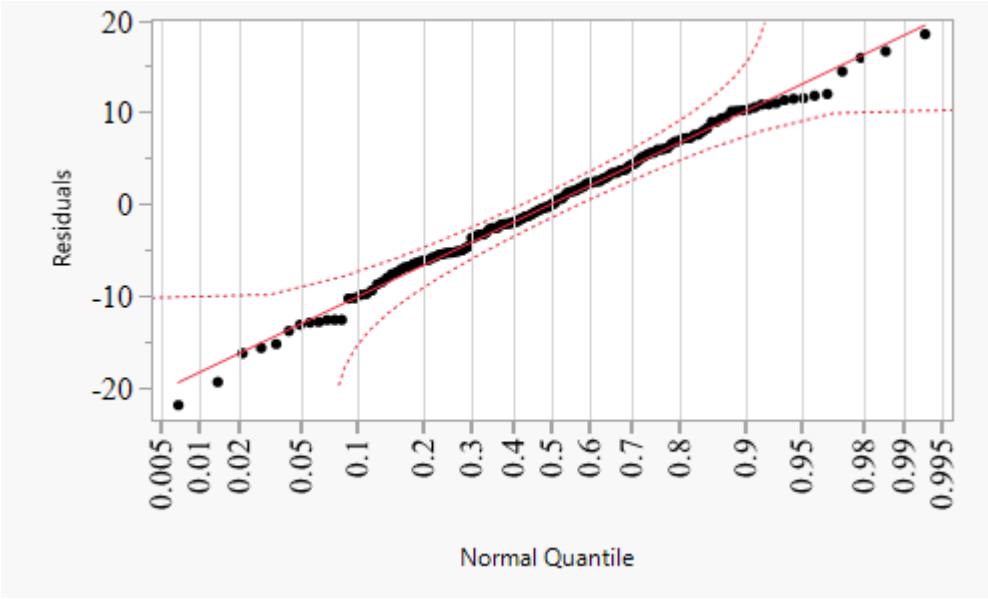


Figure No. (4.4): Q-Q PLOT

- Statistical Evidence:

Statistical tests provide formal evidence for or against normality but are sensitive to sample size. The Shapiro-Wilk test is widely regarded as one of the most powerful tests for normality. A p-value greater than 0.05 indicates no significant deviation from normality, while a p-value less than 0.05 suggests the residuals are not normally distributed (Ghasemi & Zahediasl, 2012). However, the P value of the Shapiro-Wilk test is 0.826, indicating a normal residual distribution.

### 4.4.3. The Mean of Residuals Test

The one-sample t-test is a statistical method used to determine whether the mean of a single sample differs significantly from a known or hypothesized population mean (Studenmund, 2014). This test assumes that the data are approximately normally distributed and is commonly applied to assess the validity of theoretical expectations. However, the one-sample t-test indicates P Value of 1.00. Thus, it fails to reject H0: No significant evidence that the mean of the residuals differs from zero. Figure (4.5) presents that.

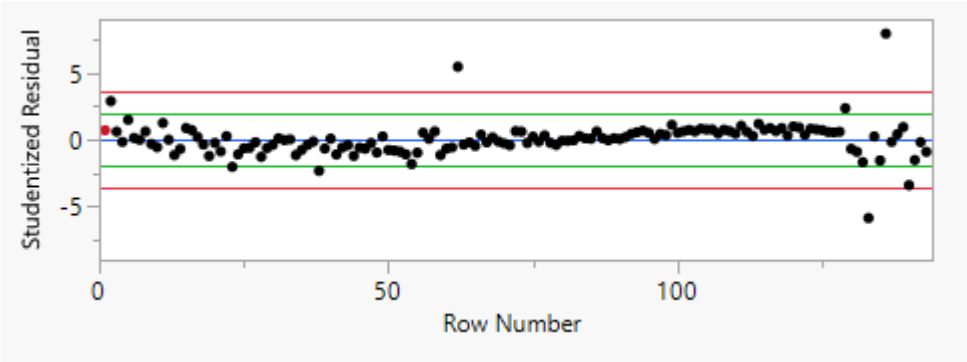


Figure No. (4.5): Studentized Residuals

### 4.4.4. The Stationarity of Residuals

According to Dickey & Fuller (1979), the test for stationarity assumes both a mean and a linear trend. Trend ADF = (−5.3806); this value is very negative and significantly below typical critical values (<−4.0 for 1% significance). This result indicates the stationarity of residuals when a trend is included, as shown in Figure (4.6).

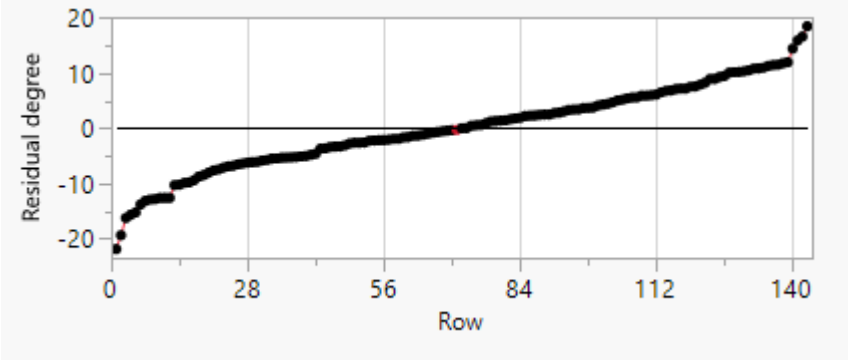


Figure No. (4.6): Stationarity of residuals

### 4.4.5. Heteroskedasticity Test and Residual Independency.

Heteroskedasticity occurs when the variance of residuals in a regression model is not constant across the range of predicted values or independent variables. Testing for heteroskedasticity is done using visual diagnostics and formal statistical tests (Breusch & Pagan, 1979; White, 1980) as follows in Figure (4.7).

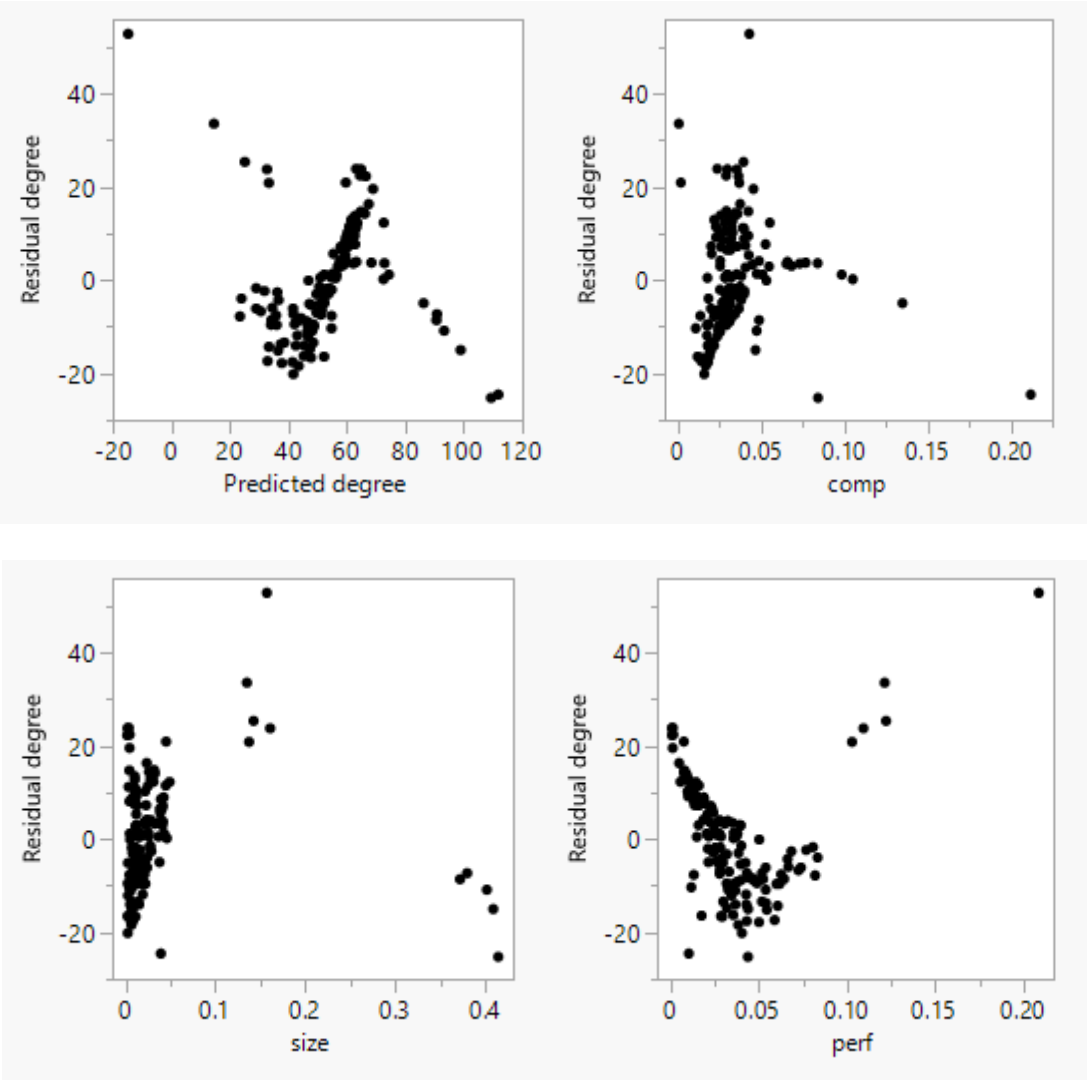


Figure No. (4.7): Residuals Vs. Predictors

Breusch and Pagan (1979) state that the scattered points indicate homogeneous variances. However, the P value of the Levenes test is equal to 0.11, which means it fails to reject the null hypothesis. This means there is no statistically significant evidence to suggest that the variances across the groups are unequal. Thus, the assumption of homogeneity of variances is satisfied.

Further analysis is to test the independence of residuals. A Durbin-Watson statistic of 1.5 to 2.5 suggests that autocorrelation is not a significant problem in the residuals (Gujarati & Porter, 2009; Enders, 2014; Wooldridge, 2020). The test presents 1.509. This means that

the residuals in the regression model are approximately independent, satisfying one of the key regression assumptions.

### 4.4.6. Predictors' Correlations

One key test of the regression assumption is to ensure that there is no perfect correlation between the predictors. The graphs in Figure (4.8) present the scattered distribution between the predictors.

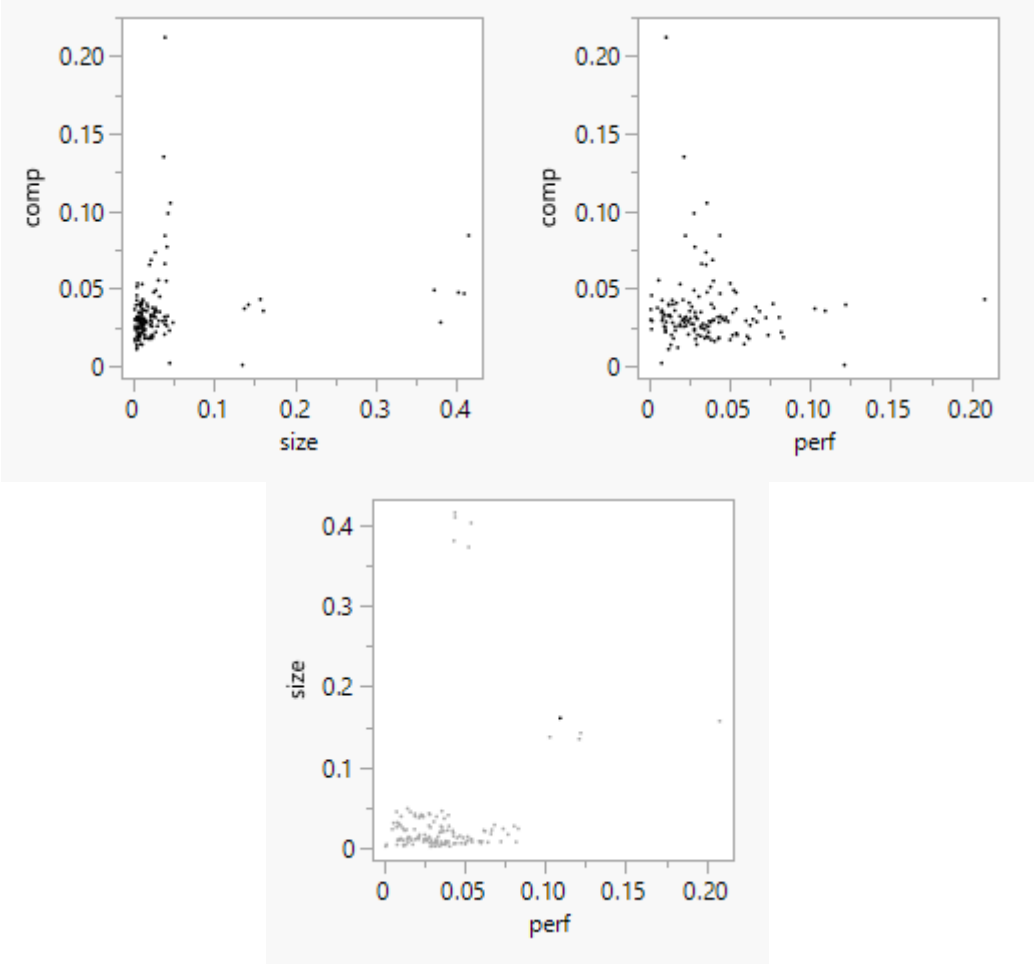


Figure No. (4.8): Predictors Correlations

However, Table (4.1) presents the Pearson correlations between the predictors and provides statistical evidence of non-correlated predictors.

Table No. (4.1): Correlation of predictors

| | Intercept | comp | size | perf |
|---|---|---|---|---|
| Intercept | 1.0000 | | | |
| Comp | -0.7007 | 1.0000 | | |
| Size | 0.1069 | -0.2146 | 1.0000 | |
| Perf | -0.6160 | 0.1398 | -0.3151 | 1.0000 |

Because of the prior analysis, the data fully satisfies all of the essential presumptions of regression analysis, confirming that the model produces accurate and impartial results. Since all assumptions have been satisfied, the regression findings may be assessed with confidence, providing a strong basis for the analysis to make perceptive conclusions. The model is reliable, precise, and suitable for accurate statistical inferences and predictions. The analysis that follows discusses the results of running the regression model.

### 4.4.7. Econometric Modeling

Most previous empirical research uses financial metrics to express the CEO's efficiency without considering the compensation itself. Furthermore, the Peer Group Comparison Model for Bizjak et al. (2008) thinks of the firm size as a control variable since it compares the firms with no significant variation in size. Also, Performance-Based Benchmarking for Bebchuk and Fried (2004) uses financial performance metrics and paid compensation without considering the firm size. The Market Median Benchmarking model for Gabaix and Landier (2008) highlights the size and paid compensation and considers the firm’s performance as a control variable. Equity-based benchmarking (Jensen & Murphy, 1990) determines the benchmark regarding Pay-for-performance sensitivity and controls the size. Therefore, it was necessary to develop a model that considers performance, compensation, and size as independent variables for benchmarking purposes. However, using solid geometry facilitates this idea, as illustrated in the study. An additional significant point is to generate a model that considers the interaction between pay compensation, firm size, and performance to benchmark the CEO, since the rational argument of previous research links all these predictors to each other. Hence, the study conducts the OLS regression model (2) with full factorial predictors. The following 3D surface proves the interaction between every two

predictors while affecting the $\theta^{\circ}$Degrees as a CEO efficiency index is consistent with the normative theory.

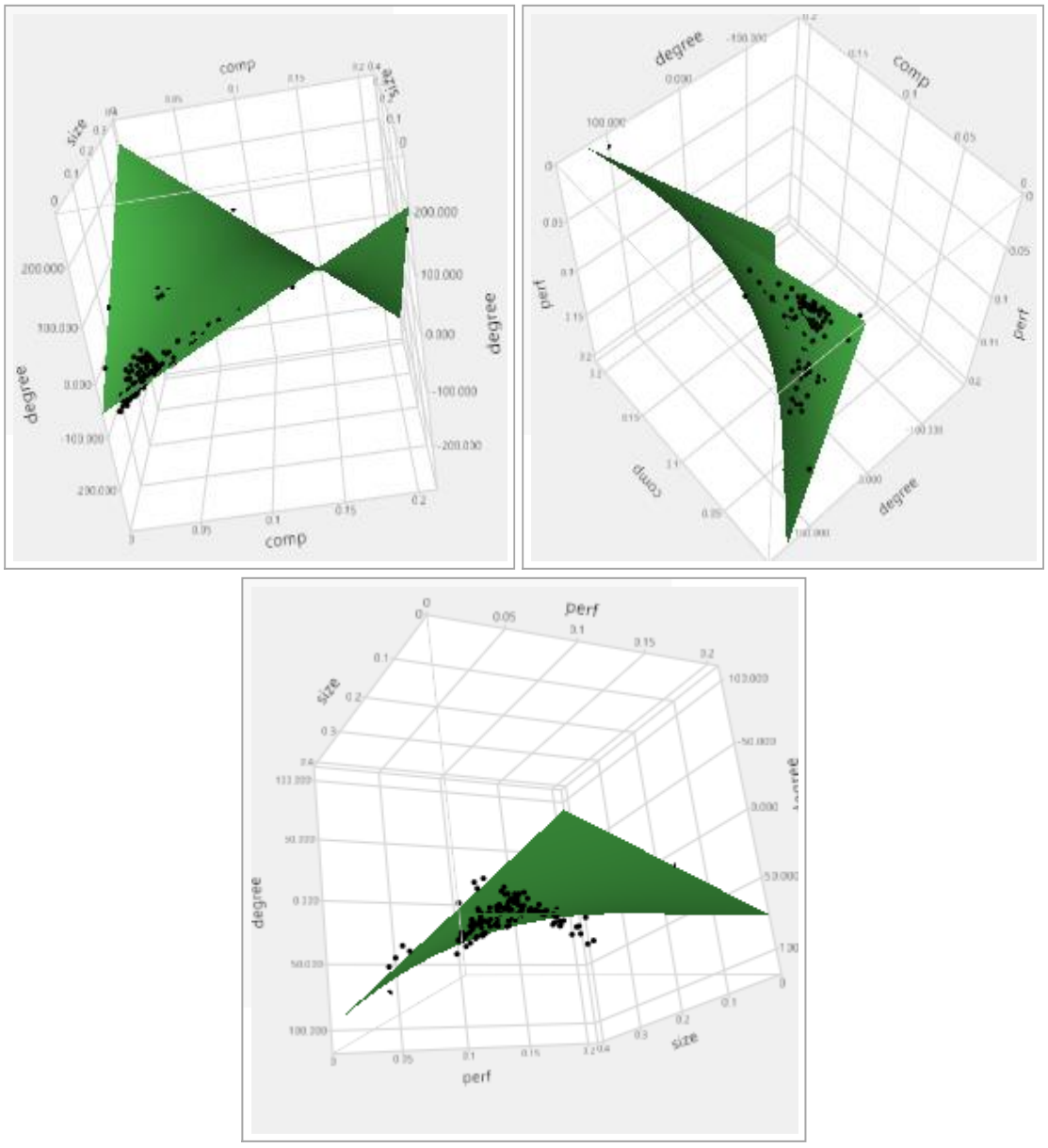


Figure No. (4.9): Interactions between the predictors

The green surface in Figure (4.9) represents the relationship between the three variables. It could indicate a mathematical model, an empirical fit, or functional dependency. According to Montgomery et al. (2021), 3D surface plots are often used to visually represent regression models, helping to evaluate the fitness and trends in multidimensional data. The black dots likely represent actual data points, while the surface mainly defines a predicted or

theoretical model; if the black points fall on the surface, it means that the interaction exists and is close to being significant. Such plots are essential in visualizing the relationship between independent and dependent variables, particularly in cases involving interaction effects (Montgomery et al., 2021).

- **Regression Analysis**

This phase of analysis is critical; the primary purpose of it is to provide statistical evidence of the $\theta^{\circ}$Degree's validity to express CEO efficiency. According to the normative CEO compensation, CEO efficiency should be positively and significantly affected by firm performance, negatively and significantly affected by firm size, and negatively and significantly affected by paid compensation concurrently.

- **Descriptive Statistics**

As presented in Table (4.2), the minimum $\theta^{\circ}$ Degree (15.58) expresses the most efficient CEO, and the maximum (88.74) is the less efficient CEO.

Table No. (4.2): Descriptive statistics

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| **Comp** | 143.00 | 0.001 | 0.212 | 0.035 | 0.024 |
| **Size** | 143.00 | 0.002 | 0.415 | 0.035 | 0.074 |
| **Perf** | 143.00 | 0.001 | 0.208 | 0.035 | 0.027 |
| **Degree** | 143.00 | 15.581 | 88.749 | 53.364 | 20.385 |

- **Regression Results**

The following Figure (4.10) proves the regression line and fits with 0.857 R squared and P value <0.0001, which means that the change in predictors significantly explains 85% of changes in CEO efficiency (Studenmund, 2014):

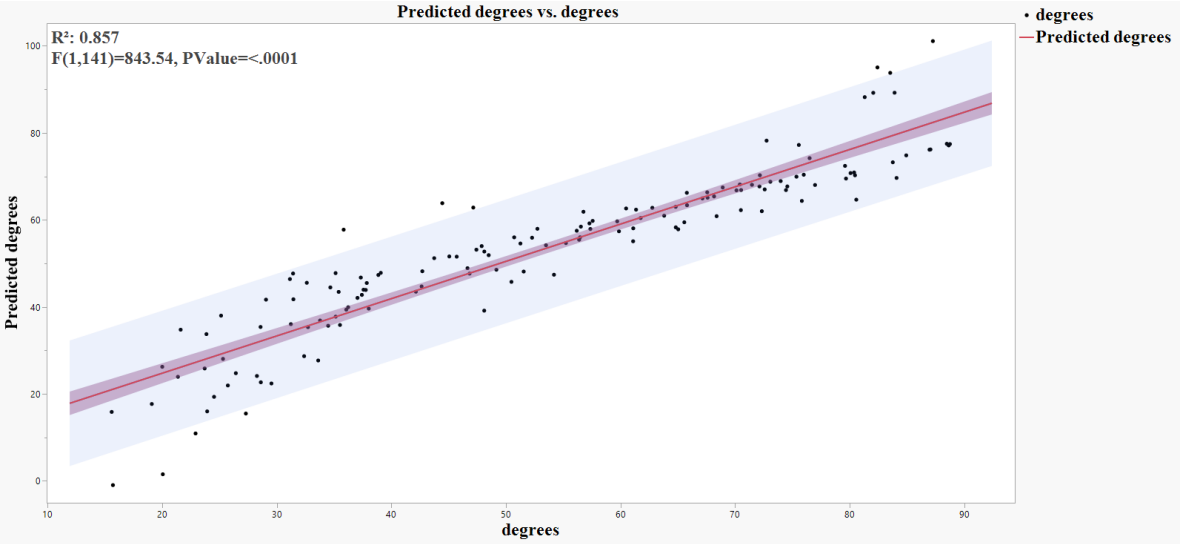


Figure No. (4.10): Regression Fit

Moreover, Table (4.3) presents the significance of $\theta^{\circ}$ Predictors. According to Neter al. (1996), To make it easier to understand the significance of variables, log worth values offer a logarithmic transformation of p-values. A lower p-value and, thus, a more statistically significant effect are indicated by a greater Log Worth.

Table No. (4.3): Predictors' Significance

| Source | Log worth | P Value |
|---|---|---|
| Perf | 42.284 | 0.00000 |
| size*perf | 19.672 | 0.00000 |
| Comp | 14.944 | 0.00000 |
| Size | 9.187 | 0.00000 |
| comp*perf | 3.441 | 0.00036 |
| comp*size | 2.407 | 0.00392 |
| comp*size*perf | 2.141 | 0.00723 |

As shown in Table 4.8, all the predictors have a significant P value. Perf (performance) has the highest Log Worth (42.284) and the smallest p-value. This indicates that it is the most significant predictor of the response variable. The interaction term size*perf (Log Worth = 19.672) is also highly significant, suggesting that the effect of perf on the outcome depends on the firm's size. Comp (compensation) and size are significant individual predictors, as indicated by their high Log Worth values (14.944 and 9.187, respectively). Interaction terms like comp*perf, comp*size, and comp*size*perf have lower Log Worth but remain statistically significant (Log Worth > 2 corresponds to $p<0.01p < 0.01p<0.01$). Significant

interaction terms (e.g., size*perf, comp*perf) indicate that the relationship between predictors and the outcome variable changes depending on the levels of other variables. For example, comp*perf implies that the impact of compensation on the response depends on performance. Interaction analysis statistically proves the 3D surface visual analyses. This is consistent with rational arguments and compensation process theories since contracting CEO compensation primarily depends on performance and size. Conversely, CEO efficiency depends on firm size and performance, and paid compensation interacts with each other.

On the other side, Table (4.4) shows the direction of the relationship between $\theta^{\circ}$Degree and its predictors.

Table No. (4.4): Predictors' coefficients

| Term | Estimate | Prob>\|t\| |
|---|---|---|
| Intercept | 59.17 | <.0001* |
| Comp | 382.45 | <.0001* |
| Size | 91.53 | <.0001* |
| (comp-0.03474) *(size-0.03497) | -1766.86 | 0.0039* |
| Perf | -683.40 | <.0001* |
| (comp-0.03474) *(perf-0.03497) | 8161.52 | 0.0004* |
| (size-0.03497) *(perf-0.03497) | 4657.52 | <.0001* |
| (comp-0.03474) *(size-0.03497) *(perf-0.03497) | -95105.43 | 0.0072* |

1. Intercept (59.17): The intercept represents the expected baseline level of CEO efficiency ($\theta^{\circ}$Degree) when CEO compensation, firm size, and firm performance are at their centered values. The intercept suggests that firms possess a fundamental level of CEO efficiency that persists despite extreme compensation levels, firm size effects, or performance shocks. Thus, baseline CEO efficiency may stem from several factors not captured in this model, such as CEO education or skills, organizational culture, and leadership development practices.
2. Main Effects:

- Comp (382.45): A positive coefficient suggests that the $\theta^{\circ}$Degree variable increases by 382.45 units on average as comp increases by one unit. This effect is highly significant (p-value <.0001).
- Size (91.53): A positive coefficient, implying an increase in the $\theta^{\circ}$Degree increases by 91.53 with a one-unit increase in size. Also, significant (p-value <.0001). Perf (-

683.40): A negative coefficient, indicating a decrease in the $\theta^{\circ}$Degree by 683.40 units with an increase in performance by one unit. This is statistically significant (p-value <.0001).

3. Interaction Effects:

- (comp-0.03474) * (size-0.03497): The negative coefficient (-1766.86) suggests that the interaction between comp and size reduces the $\theta^{\circ}$Degree variable. This effect is statistically significant (p-value 0.0039). This indicates that in larger firms, high CEO compensation may be embedded within more robust governance structures, thereby neutralizing the adverse effects typically associated with excessive pay or complex organizational scale. This result supports the market median benchmarking model of Gabaix and Landier (2008); they primarily focus on firm size when benchmarking executive compensation. According to their hypothesis, larger companies are prepared to pay more to attract top executive talent because a competent CEO may significantly increase the value of a huge corporation.
- (comp-0.03474) * (perf-0.03497): The positive coefficient (8161.52) indicates that the interaction between comp and perf increases the $\theta^{\circ}$Degree. It is statistically significant (p-value 0.0044), which decreases the CEO's efficiency; this result may relate to the potential overconfidence effect or the CEO's pressure that contributes to relatively maximizing the compensation, much more than the increase in performance.
- (size-0.03497) * (perf-0.03497): The positive coefficient (4657.52) suggests an increase in the $\theta^{\circ}$Degree with the interaction of size and performance. Highly significant (p-value <.0001). Decreasing the CEO's efficiency may occur because the increase in performance is not sufficient to counteract the effect of the common idea that a large firm needs higher compensation.
- (comp-0.03474) * (size-0.03497) * (perf-0.03497): The negative coefficient (-95105.43) implies a considerable reduction in the $\theta^{\circ}$Degree due to the three-way interaction. This is significant (p-value 0.0072). In large, high-performing firms with highly compensated CEOs, robust organizational structures, and governance mechanisms may mitigate the risk of efficiency reduction.

To conclude, $\theta^{\circ}$Degree is highly and significantly explained by CEO pay, firm size, and performance, consistent with the normative CEO compensation. Therefore, $\theta^{\circ}$Degree is considered a significant index to express CEO efficiency as discussed by Oberholzer (2016). However, it is important to mention that this is the first model that captures the interaction between the main factors that affect the CEO's efficiency compared with the existing models in the literature discussed in chapter two.

In contrast, the study conducts the same analysis using Cos $\theta^{\circ}$ instead of $\theta^{\circ}$Degree as an index. The analysis indicates a fit model, with P value <.0001 and 0.82 R squared. However, it violates the assumption of normal distribution residuals, and there is no interaction between CEO compensation and firm performance. However, transforming the predictors to the square root and excluding five outliers with a Cook's Distance of more than 0.027 solves the issue and provides a fit model with 0.81 R squared; it may refer to the nature of the DOW Jones Panel data. Table (4-5) presents the results.

Table No. (4.5): Cos $\boldsymbol{\theta}^{\circ}$index

| Term | Estimate | Std Error | t Ratio | Prob>\|t\| |
|---|---|---|---|---|
| Intercept | 0.6206776 | 0.023809 | 26.07 | <.0001* |
| comp | -3.450555 | 0.500804 | -6.89 | <.0001* |
| size | -2.585386 | 0.359437 | -7.19 | <.0001* |
| (comp-0.0333) *(size-0.0263) | 160.60826 | 25.60578 | 6.27 | <.0001* |
| perf | 8.3350368 | 0.417518 | 19.96 | <.0001* |
| (comp-0.0333) *(perf-0.03426) | 119.22718 | 38.84699 | 3.07 | 0.0026* |
| (size-0.0263) *(perf-0.03426) | -28.78783 | 8.603712 | -3.35 | 0.0011* |
| (comp-0.0333) *(size-0.0263)*(perf-0.03426) | -3069.719 | 954.7972 | -3.22 | 0.0016* |

The results are entirely consistent with $\theta^{\circ}$Degree results: Higher performance and lower compensation and size lead to increased Cos $\theta^{\circ}$ and, in turn, increased CEO efficiency. Hence, both Cos $\theta^{\circ}$ and $\theta^{\circ}$Degree considers significant indices to express CEO efficiency; it refers to concerned parties, policymakers, data type, and market circumstances. For future research purposes, both are usable and conditional in matching the underlying assumptions of regression modeling; each data type has its conditions.

### 4.4.8. Additional Validity Test

This part of the analysis provides additional evidence of CEO efficiency indices and illustrates how to use the index to calculate the desired adjustment in CEO compensation for peer firms.

- **Calculating Adjusted CEO Compensation**

After determining the benchmark firm by $\theta^{\circ}$Degree; concerned firms can use this index in equation (1) to calculate their desired CEO compensation to match the benchmark index. Suppose that the benchmark is the market average of Cos $\theta^{\circ}$ Which equals to 0.597, and $(53.364)^{\circ}$ Policymakers can adjust the actual compensation to match the benchmark firm. Appendix Six presents the actual versus adjusted CEO compensation. The benchmark index can adjust to 107 observations out of 143 because of the considerable variation between the benchmark and the (upper-down) tail of the market; the high variation leads to complex numbers (square root of minus one of compensation), which do not have a financial meaning. However, it can be solved by changing the desired firm's performance required from the CEO to achieve the benchmark. However, in practice, the market may have three benchmarks (upper, average, down) or refer to the parties concerned. 107 observations are more than sufficient to compare the regression models (3) and (4).

- **Generalized Least Squares**

After calculating the adjusted CEO compensation, this section compares the actual and adjusted CEO compensation with firm size and firm performance as predictors. Nonetheless, Agresti (2015) offers a thorough defense of using generalized linear models (GLMs) to expand standard linear regression models, making them appropriate for an expanded range of data distributions and forms.

According to the traditional linear regression model, there is a linear relationship between the predictors and the mean response, and the response variable has a normal distribution. A more adaptable modeling approach is required since response variables in many real-world applications do not meet these assumptions; they can be binary, categorical, count-based, or skewed. By permitting the response variable to follow any member of the exponential group of distributions, such as the normal, binomial, Poisson, and gamma

distributions, GLMs overcome these restrictions. With this adaptability, analysts can continue to use a single theoretical framework while modeling an expanded range of data types.

Additionally, GLMs introduce link functions, which relate the expected value of the response variable to a linear predictor through a transformation. Common link functions, such as the logit (for logistic regression), log (for Poisson regression), and identity (for standard linear regression), allow for appropriate modeling of non-normally distributed responses. By incorporating maximum likelihood estimation (MLE) instead of ordinary least squares, GLMs provide efficient parameter estimation in situations where normality and homoscedasticity assumptions do not hold.

Furthermore, Agresti (2015) emphasizes that GLMs are widely used in econometrics, epidemiology, and social sciences, where data often exhibit heteroskedasticity, skewness, or non-linearity. Their application extends simple regression to logistic regression for binary outcomes, Poisson regression for count data, and gamma regression for continuous positive responses. These models are integrated with the GLM framework, which makes it an effective tool for applied statistical analysis. The employment of GLMs is, therefore, justified by their ability to accommodate a variety of data types, improve model interpretability, and offer trustworthy statistical inference while applying standard linear models to a larger number of real-world problems.

However, the benchmark index can adjust to 107 observations out of 143; this simple size leads to violating the normally distributed residuals. Therefore, the study uses generalized linear models to investigate the differences between actual and adjusted CEO compensation.

- **Adjusted CEO compensation and its predictors**

The analysis employs a generalized linear model with Maximum Likelihood Estimation (MLE) to assess the relationship between the response variable adjusted compensation (adj. comp) and predictor variables (firm size and firm performance). The model assumes a normal distribution with an identity link function, which is appropriate when modeling a continuous response variable (McCullagh & Nelder, 1989).

Table (4.6) presents the model fit; the log-likelihood ratio test compares the full and reduced models. The entire model log-likelihood is -396.38, while the reduced model log-likelihood is -218.26. The likelihood ratio (L-R) Chi-Square statistic is 356.22 with 2 degrees

of freedom (DF), which is highly significant ($p < 0.0001$). This indicates that the model explains significantly more variation in adjusted compensation than the null model (Agresti, 2015).

Table No. (4.6): Model Test

| Model | -Log Likelihood | L-R Chi Square | DF | Prob>Chi Sq |
|---|---|---|---|---|
| Difference | 178.114486 | 356.2290 | 2 | <.0001* |
| Full | -396.38291 | | | |
| Reduced | -218.26843 | | | |

The goodness-of-fit statistics in Table (4.7), including the Pearson Chi-Square (0.0038, DF = 104, p = 1.0000) and Deviance statistics (0.0038, DF = 104, p = 1.0000), suggest that the model fits the data very well, as extremely low residual values indicate slight unexplained variance.

Table No. (4.7): Goodness of Fit

| Goodness Of Fit Statistic | Chi Square | DF | Prob>Chi Sq | Overdispersion |
|---|---|---|---|---|
| Pearson | 0.0038 | 104 | 1.0000 | 0.0000 |
| Deviance | 0.0038 | 104 | 1.0000 | |

The Akaike Information Criterion (AICc) value is -784.37, which suggests a strong fit compared to alternative models. Lower AIC values indicate better model performance (Burnham & Anderson, 2002).

The effect summary in Table (4.8) provides an overall significance ranking for each predictor variable:

- Performance (perf): The log-worth is 75.287, with a p-value < 0.0001, indicating a highly significant effect on adjusted compensation.
- Size (size): The log worth is 41.619, with a p-value < 0.0001, also showing a strong influence.

Table No. (4.8): Effect summary

| Source | Log worth | P Value |
|---|---|---|
| perf | 75.287 | 0.00000 |
| size | 41.619 | 0.00000 |

The likelihood ratio Chi-Square tests presented in Table (4.9) confirm the statistical significance of the predictor variables:

- Size: L-R Chi-Square = 185.97, DF = 1, $p < 0.0001$.
- Performance: L-R Chi-Square = 340.42, DF = 1, $p < 0.0001$.

These results demonstrate that both firm size and performance significantly influence adjusted CEO compensation.

Table No. (4.9): Effect Test

| Source | DF | L-R Chi Square | Prob>Chi Sq |
|---|---|---|---|
| size | 1 | 185.97284 | <.0001* |
| perf | 1 | 340.42116 | <.0001* |

Table (4.10) shows the perimeter estimate:

- Intercept (-0.000393, $p = 0.7110$): The intercept is not statistically significant, meaning there is no meaningful base level of adjusted compensation when both predictors are zero.
- Firm Size (-0.72102, $p < 0.0001$): The coefficient is negative, indicating that larger firms tend to decrease adjusted compensation, which may suggest a dilution effect in larger organizations (Core et al., 1999).
- Performance (1.5237, $p < 0.0001$): The positive and significant coefficient means that better firm performance leads to higher adjusted compensation, aligning with pay-for-performance theories (Murphy, 2013).

Table No. (4.10): Perimeters Estimate

| Term | Estimate | Std Error | L-R Chi Square | Prob>Chi Sq | Lower CL | Upper CL |
|---|---|---|---|---|---|---|
| Intercept | -0.000393 | 0.0010602 | 0.1373237 | 0.7110 | -0.00249 | 0.0017038 |
| size | -0.72102 | 0.0321988 | 185.97284 | <.0001* | -0.784699 | -0.657341 |
| perf | 1.5236987 | 0.0306592 | 340.42116 | <.0001* | 1.4630644 | 1.5843331 |

In summary, this model offers compelling evidence that, as firm size has a negative impact, firm performance greatly raises adjusted CEO remuneration. These results are consistent with the literature on normative executive remuneration, which shows that compensation packages are dominated by performance-based pay systems (Bebchuk & Fried,

2004). According to statistical testing, the model fit is satisfied, and both predictors are very significant.

- **Actual CEO compensation and its predictors**

As shown in Table (4.11), the log-likelihood ratio (L-R) test assesses the overall model significance:

- Full model log-likelihood = -306.78762
- Reduced model log-likelihood = -302.6074
- Difference in log-likelihood = 4.1802
- L-R Chi-Square statistics = 8.3604, with 2 degrees of freedom (DF)
- p-value = 0.0153, indicating a statistically significant model.

Model comparison using generalized least squares revealed that the reduced model, excluding one predictor, achieved a higher log-likelihood (-302.6074) than the complete model (-306.78762), with a log-likelihood difference of 4.1802. This finding indicates that simplifying the model may slightly improve fit, suggesting that one of the variables (either performance or size) provides limited additional explanatory power when the other is already included.

Since p = 0.0153 (< 0.05), conclude that the model significantly improves upon the null model, suggesting that the predictor variables (size and performance) are meaningful contributors to variations in CEO compensation (Agresti, 2015).

Table No. (4.11): Model fit Test

| Model | -Log Likelihood | L-R Chi Square | DF | Prob>Chi Sq |
|---|---|---|---|---|
| Difference | 4.1802221 | 8.3604 | 2 | 0.0153* |
| Full | -306.78762 | | | |
| Reduced | -302.6074 | | | |

Goodness of fit in Table (4.12) presents that:

- Pearson Chi-Square = 0.0203, DF = 104, p = 1.0000
- Deviance = 0.0203, DF = 104, p = 1.0000
- Overdispersion = 0.0002
- AICc (Akaike Information Criterion, corrected) = -605.1831

Since the Pearson Chi-Square and Deviance p-values are 1.0000, the model fits the data very well, with negligible overdispersion.

A lower AICc value indicates a better-fitting model. Compared to alternative models, the AICc of -605.1831 supports model adequacy (Burnham & Anderson, 2002).

Table No. (4.12): Goodness of Fit

| Goodness Of Fit Statistic | Chi Square | DF | Prob>Chi Sq | Overdispersion |
|---|---|---|---|---|
| Pearson | 0.0203 | 104 | 1.0000 | 0.0002 |
| Deviance | 0.0203 | 104 | 1.0000 | |

The effect summary in Table (4.13) evaluates the importance of the predictors:

- Firm Sizes' Log worth = 2.375, and p-value of 0.004, indicating a significant explanatory factor.
- Firm Performance' Log-worth = 1.775, and p-value of 0.016, indicating a significant explanatory factor.

These findings imply that firm size is more influential in explaining compensation variations than performance.

Table No. (4.13): Effect Summary

| Source | Log worth | P Value |
|---|---|---|
| size | 2.375 | 0.00422 |
| perf | 1.775 | 0.01680 |

The likelihood ratio Chi-Square tests -as shown in Table (4.14) for each variable confirm their significance:

- Size:

  L-R Chi-Square = 8.1876, DF = 1, p = 0.0042. Suggests that size has a strong effect on compensation.
- Performance:

  L-R Chi-Square = 5.7169, DF = 1, p = 0.0168. It indicates that performance has a significant but weaker effect on compensation.

Both variables significantly contribute to the model, but firm size has a stronger influence than performance.

Table No. (4.14): Effect Test

| Source | DF | L-R Chi Square | Prob>Chi Sq |
|---|---|---|---|
| size | 1 | 8.1875594 | 0.0042* |
| perf | 1 | 5.7168741 | 0.0168* |

Table (4.15) presents the parameter estimates, and the following interpretation illustrates the results.

- Intercept (0.03399, $p < 0.0001$)

  The intercept represents the base level of compensation when both size and performance are zero.

  Since it is significant, it suggests that baseline compensation exists regardless of firm size or performance.

- Firm Size (0.21698, $p = 0.0042$)

  A positive coefficient means that larger firms tend to offer higher compensation.

  A 1-unit increase in size leads to a 0.217 increase in compensation, holding other factors constant.

  Since $p < 0.01$, this effect is highly significant.

- Performance (-0.17164, $p = 0.0168$).

  A negative coefficient means that higher firm performance is associated with lower compensation.

  A 1-unit increase in performance leads to a 0.172 decrease in compensation, holding other factors constant.

  Since $p < 0.05$, this effect is statistically significant but less pronounced than firm size.

Table No. (4.15): Parameter Estimates

| Term | Estimate | Std Error | L-R Chi Square | Prob>Chi Sq | Lower CL | Upper CL |
|---|---|---|---|---|---|---|
| Intercept | 0.03399 | 0.0024494 | 110.15841 | <.0001* | 0.0291459 | 0.0388342 |
| size | 0.2169849 | 0.074386 | 8.1875594 | 0.0042* | 0.0698726 | 0.3640972 |
| perf | -0.17164 | 0.0708293 | 5.7168741 | 0.0168* | -0.311718 | -0.031562 |

## 4.5. An Extra Analysis

This analysis section aims to apply the traditional approach to measuring independent variables in Model 2. While the previous analysis relied on market share as a proxy for firm

size, performance, and CEO compensation, this analysis adopts a different methodology. It measures the predictor variables using the natural firm size and the CEO compensation logarithm. Additionally, firm performance is expressed through earnings per share, providing a more conventional metric for assessing financial performance. By implementing these traditional measurement techniques, this analysis seeks to offer a more standardized and comparable evaluation of the relationships among these key variables to predict the of CEO efficiency measured by cosine Theta by equation (1).

The study conducts generalized least squares due to violating the normal distribution assumption; however, the model fit and significance results are as follows.

- **Likelihood Ratio Chi-Square Test (LR Test)**

Chi-Square Statistic: 918.302

Degrees of Freedom: 3

p-value: < 0.0001, The model is highly significant, meaning at least one of the predictors strongly influences Cos.

- **Goodness-of-Fit Tests (Pearson and Deviance)**

Chi-Square: 0.0002

DF: 138

p-value: 1.0000, The model has an excellent fit, with no sign of overdispersion.

- **AICc (Akaike Information Criterion, corrected):** -1510.781. A lower AIC indicates a better model fit.

Thus, the model explains the data well, meaning the predictors (performance, compensation, and firm size) firmly explain variations in CEO efficiency.

- **Effect Summary:**

The Log worth values in Table (4.16) indicate the importance of each variable in explaining CEO efficiency. The larger the Log worth, the more influential the variable.

Table No. (4.16): Effect Summary

| Source | Log worth | P Value |
|---|---|---|
| perf | 199.423 | 0.00000 |
| log size | 43.703 | 0.00000 |
| log comp | 2.634 | 0.00232 |

Performance (perf) is Cos's most dominant factor, with a high Log worth (199.423). Firm Size (log size) has a strong effect, though less than performance (43.7). Log Compensation (log comp) has the weakest effect but is still statistically significant. (2.6)

- **Effect Test**

Table No. (4.17): Effect Test

| Source | DF | L-R Chi Square | Prob>Chi Sq |
|---|---|---|---|
| perf | 1 | 911.10975 | <.0001* |
| log comp | 1 | 9.2745995 | 0.0023* |
| log size | 1 | 195.52091 | <.0001* |

Performance (perf) has the highest L-R Chi-Square value, reinforcing its dominance in the model. Log Size (log size) is also highly significant (second-highest influence). Log Compensation (log comp) has a weaker effect but remains significant.

- **Direction and Magnitude of Effects (Parameter Estimates)**

The coefficients tell the direction and magnitude of each variable's effect on Cosine (CEO efficiency).

Table No. (4.18): Parameter Estimates

| Term | Estimate | Std Error | L-R Chi Square | Prob>Chi Sq | Lower CL | Upper CL |
|---|---|---|---|---|---|---|
| Intercept | 0.0614358 | 0.0031416 | 185.51626 | <.0001* | 0.0552365 | 0.0676352 |
| perf | 0.0758152 | 0.0002575 | 911.10975 | <.0001* | 0.0753072 | 0.0763233 |
| log comp | -0.001271 | 0.0004105 | 9.2745995 | 0.0023* | -0.002081 | -0.000461 |
| log size | -0.004776 | 0.0002329 | 195.52091 | <.0001* | -0.005236 | -0.004317 |

- **Interpretation of Coefficients:**

1. **Intercept (0.0614, p < 0.0001)**

The baseline level of Cosine  when all predictors are zero.

2. **Performance (0.0758, p < 0.0001)**

A positive coefficient means that higher performance leads to higher Cos.

Performance is the most influential factor.

3. **Log Compensation (-0.0013, p = 0.0023)**

A negative coefficient means that higher CEO compensation is associated with lower Cosine.

The effect is small but statistically significant.

This suggests that overpaid CEOs may contribute to inefficiency or reduced firm performance.

4. **Log Size (-0.0048, p < 0.0001)**

A negative coefficient result means that larger firms have lower Cosine. Larger firms may have bureaucratic inefficiencies or more diluted executive influence. Thus, all the identified predictors align with the core assumption that CEO efficiency improves when firm performance is maximized while simultaneously minimizing both firm size and CEO compensation. This relationship underscores the importance of balancing executive incentives with overall corporate objectives to ensure optimal managerial efficiency.

- **Cosine Versus Predicted Cosine.**

The following figure presents the linearity of Cosine Theta due to using the logarithmic method to measure firm size and CEO compensation.

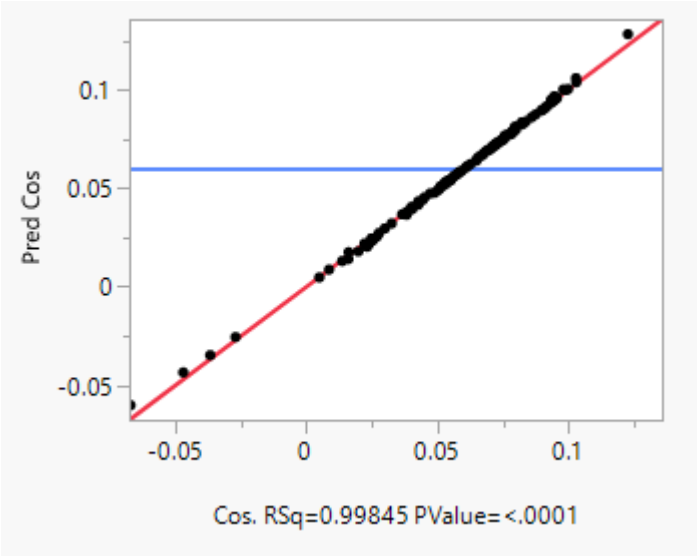


Figure No. (4.11): Cos. Vs. Predicted Cos.

As shown in Figure (4.11), the relationship between Cos (CEO efficiency) and its predictors (firm size, performance, and CEO compensation measured by traditional methods) is fully and significantly linear with 0.99 R squared.

In conclusion, using traditional methods to measure these predictors remains relevant and practical. These methods are instrumental in research and decision-making processes, providing reliable insights for assessing CEO efficiency. Based on these findings, policymakers, concerned parties, and model users can create more effective governance frameworks and compensation plans. By applying these traditional measurement techniques, stakeholders can make informed decisions that enhance corporate performance, align CEO compensation with firm objectives, and ensure sustainable business practices.

- **Market Share Approach Versus Traditional Approach**

Previous analysis proves the strength of the market share and traditional approaches. Measuring firm performance, size, and CEO compensation as a percentage of the sector or using the natural logarithm to transform the firm size and CEO compensation are valid to express CEO efficiency. However, there are essential differences between the two approaches as follows:

Table No. (4.19): Market Share Approach Versus Traditional Approach

| Measurement | Source | Log worth | P Value |
|---|---|---|---|
| Market share approach | Market share of EPS | 42.284 | 0.00000 |
| | Market share of Compensation | 14.944 | 0.00000 |
| | Market share of Size | 9.187 | 0.00000 |
| Traditional approach | EPS | 199.423 | 0.00000 |
| | Log size | 43.703 | 0.00000 |
| | Log compensation | 2.634 | 0.00232 |

As shown in Table (4.19), both approaches provide significant insights into the determinants of CEO efficiency, offering complementary perspectives on how compensation, firm size, and performance dynamics influence CEO performance efficiency.

The traditional approach establishes a strong and direct relationship between CEO compensation and firm performance, mainly when performance is measured using earnings per share. The statistical analysis reveals that the log worth of firm performance (EPS) is 199.42, which is substantially higher than the log worth of CEO compensation (2.63). This stark disparity underscores the idea that CEO compensation is a statistically significant explanatory factor in determining CEO efficiency, but it does not exert the primary influence. Rather, firm performance seems to be the primary factor influencing CEO efficiency, demonstrating that, independent of pay levels, a company's improved financial performance has a greater direct correlation with enhanced CEO efficiency. The conventional economic theory that CEOs are motivated more by company results than by their own financial incentives is supported by this data.

In contrast, the market share method, on the other hand, adopts a more comprehensive viewpoint by taking competitive positioning variables into account, recognizing that CEO efficiency is influenced by a number of factors other than just direct cash pay. The analysis in this approach demonstrates a minor variation in Log worth values, which indicates that the impact of different determinants (firm size, firm performance, and CEO compensation) is more evenly distributed. Unlike the Traditional Approach, which finds a strong dominance of firm performance in determining CEO efficiency, the market share approach suggests that no single factor overwhelmingly dictates CEO efficiency. Instead, the interplay between market positioning of CEO compensation, firm size, and performance collectively shapes the

efficiency of a CEO. By recognizing external market pressures and strategic positioning as important factors impacting their performance, this method offers a more sophisticated understanding of CEO efficiency.

### 4.6. Example from Palestine Exchange (PEX)

Since the list of firms on the Palestine Exchange lacks disclosures, the study applies the benchmark methodology to four observations from the banking sector listed on PEX. Mathematically, the measurement of Theta is minimized when the cosine Theta is maximized, and as noticed in equation (1), cosine Theta (CEO efficiency) can be maximized conditional with increasing performance or decreasing the firm size or decreasing total compensation or achieving some or all those conditions (suppose any numbers to verify this result), which consistent with the rational argument of the economic nature of CEO efficiency and normative CEO compensation(cosine Theta should be positively correlated with performance and negatively correlated with size and CEO compensation). The following analysis in Table (4.20) Applies the equation to a sample of observations from the Palestine exchange to illustrate the equation mechanism (data available at https://web.pex.ps/)

Table No. (4.20): THETA calculation, determining the benchmark firm.

| Year | Name | A.T.A(million) | N(million) | C(million) | $\mathbf{Cos}\,\boldsymbol{\theta}$ | $\boldsymbol{\theta}$(degrees) |
|---|---|---|---|---|---|---|
| 2019 | B. | 4961.06 | 38.94 | 4.70 | 0.0078 | 89.55 |
| 2020 | B. | 5537.38 | 22.41 | 5.37 | 0.0040 | 89.77 |
| 2019 | I. | 1208.96 | 14.52 | 0.55 | 0.0120 | 89.31 |
| 2020 | I. | 1413.29 | 11.17 | 0.42 | 0.0079 | 89.55 |

A.T.A: average total assets.
N: Net profit.
C: Total compensation.
$\boldsymbol{\theta}$: the angle between the vector (which is a result of the intersection point of X, Z & and Y in three-dimensional space) and the performance axis.
Note: only for illustration purposes, consistent with (Oberholzer, 2016). measures firm size by average total assets, firm performance by net profit, and total CEO compensation as it is.
Note:1 < $\boldsymbol{cos}$ ° > -1, it is lower than zero only when the firm achieves net loss, not profit.

The benchmark firm is the firm that has the lowest Theta and at the same time, has the highest $\mathrm{Cos}\,\theta$, in the current example, I 2019 is the benchmark firm, which means that the CEO of I 2019 has the willingness to receive lower compensation, in turn, exploiting lower resources to generate a higher profit when compared with the sample; thus, its considerable that he/she is the most efficient CEO of the sample. Notice that I 2020 has had the lowest compensation. However, it is not the benchmark firm because of the decreasing net profit and the increasing total assets, which is consistent with Oberholzer (2016).

After determining the optimal $\theta^{\circ}$ of the sample (the benchmark firm), calculate the desired net profit and total assets that match the actual compensations, conditional on the benchmark Theta:

Table No. (4.21): Calculate the desired average total assets and profit

| Year | Name | Desired theta | actual A.T.A(m) | Actual N (m) | Actual C(m) | Desired AT. A (m) | Desired N (m) |
|---|---|---|---|---|---|---|---|
| **2019** | B. | 89.31 | 4,961.06 | 38.94 | 4.70 | 4,759 | 55.01 |
| **2020** | B. | 89.31 | 5,537.38 | 22.41 | 5.37 | 4,920 | 59.11 |
| **2019** | I. | 89.31 | 1,208.96 | 14.52 | 0.55 | 1,208.96 | 14.52 |
| **2020** | I. | 89.31 | 1,413.29 | 11.17 | 0.42 | 1,090 | 13.12 |

A.T.A: average total assets.
N: Net profit.
C: Total compensation.

Mathematically, the user of the equation has the choice (subjective judgment) to match the desired theta by variating a specific variable or examine the most appropriate combination of those variables conditional with the benchmark Theta to be considered the desired performance demanded from the CEO to maximize his/her efficiency. As shown in Table (4.21):

I 2019 is the benchmark firm.

B 2019 has attained 29% lower than the required profit, also there are 7.7% unexploited assets conditional with the desired (potential) Theta.

B 2020 has attained 62% lower than the required profit, also there are 11.1% unexploited assets conditional with the desired Theta.

I 2020 has attained 14% lower than the required profit, also there are 29.6% unexploited assets conditional with the desired Theta.

To achieve the efficiency of the benchmark firm, the tested firms could enhance those ratios by matching both total assets and profit to achieve the appropriate compensation.

Note: Since the total assets and CEO compensation vary widely, the results may present complex numbers (square root of minus one). However, this issue can be avoided by

converting the firm (x) factors to a percentage of the sum of the firm's sector, as explained in the result validation of the Theta equation.

# 5. Chapter Five: Conclusion

## 5.1. Study Summary and Key Findings

The study's overall objective is to derive a model that provides policymakers with an index to express CEO efficiency and test its validity consistently with the primary study assumption. The results indicate that H1 is accepted. This is consistent with the primary assumption of CEO efficiency since higher firm performance leads to a decrease in θ^° Degree and decreasing θ^° Degree means higher CEO efficiency. This result is consistent with the rational argument of the previous models and empirical studies that argue that the CEO's efficiency is primarily linked to financial indicators, which reflect how efficiently a CEO utilizes company resources to generate returns for investors (Jensen & Meckling, 1976).

The results indicate that H2 is accepted, consistent with the primary assumption of CEO efficiency since a higher firm size leads to an increase in θ^°Degree and increasing θ^°Degree means lower CEO efficiency. This result provides a solution to the butterfly effect, as demonstrated by Gabaix and Landier (2008); their competitive model shows that even small changes in firm size can significantly increase CEO pay. Thus, using the θ^°The degree index ensures that the CEO's pay will follow an objective and fair judgment. However, it is not enough for a large company to get higher compensation. The CEO's compensation must be linked to other predictors. Furthermore, this result supports the arguments of Oberholzer (2016), who concludes that lower size while achieving the same performance and same compensation is considered more efficient than peer firms.

The results indicate that H3 is accepted, which is consistent with the primary assumption of CEO efficiency, since higher compensation leads to an increase in θ^°Degree and increasing θ^°Degree means lower CEO efficiency. This result supports Oberholzer's (2016) arguments, which conclude that lower compensation, while achieving the same performance and utilizing the same size of resources, is considered more efficient than that of peer firms.

On the other hand, the comparison between the actual compensation and the adjusted compensation using the θ^°Degree equation indicates that H4 and H5 are accepted. The findings show a positive relationship between firm size and actual CEO compensation. This

result is consistent with considerable empirical evidence that CEO compensation packages for bigger firms are greater (Gabaix & Landier, 2008). This viewpoint justifies higher CEO compensation by arguing that managing a larger business requires more complexity, responsibility, and risk.

However, this theoretical expectation is not supported by the relationship between CEO compensation and firm performance. In line with earlier research, such as studies by Nourayi (2006) and Miller (2012), the results show a negative and significant correlation between CEO compensation and firm performance. This inverse relationship implies that when company performance deteriorates, CEOs might put a lot of pressure on themselves to get paid more, either to keep their financial incentives or to balance out the perceived risks of subpar performance. This phenomenon prompts questions about whether CEO compensation plans actually reflect managerial power dynamics or effectively align with shareholder interests.

In contrast, the results indicate a different pattern when adjusting CEO compensation to align with normative expectations. The adjusted CEO compensation is more consistent with the theoretically justified compensation levels, where higher firm performance, using the minimum resources (smaller firm size), is a key determinant of appropriate executive pay. According to that, CEOs of smaller businesses that achieve better financial results should receive higher compensation than their peers within an ideal pay structure. This would demonstrate a more fair and performance-based method of paying executives.

Overall, these findings suggest that firm size dominates the formation of compensation structures, even though CEO compensation is responsive to organizational scale and firm outcomes. The results emphasize that in order to guarantee alignment with organizational objectives, boards and governance bodies must critically evaluate how firm size and performance metrics are taken into account when determining executive compensation.

To conclude, the efficient CEO is defined as the CEO who can exploit the minimum economic resources to generate maximum profit and, in turn, achieve the minimum compensation. The analysis proves that the derived index is valid (with 0.86 R-squared) for expressing CEO efficiency and can be used to provide more significant compensation. θ^°

and its Cosine is considered a valid index of the CEO's efficiency. Specifically, θ^° is a measurement of the angle between the vector (which results from the intersection point of (size, performance, and compensation in three-dimensional space) and the performance axis. Equation (1) measures the index (θ^° and its Cosine), while θ^° Predictors work together to determine the CEO's efficiency; firm performance, size, and CEO payments significantly interact.

### 5.2. Contributions to Academic Literature and Practice.

According to agency theory, the issues of asymmetric knowledge and moral hazard frequently arise from the division of managerial power and ownership in listed companies, allowing managers to pursue self-serving objectives that might not be in the best interests of shareholders (Coughlan & Schmidt, 1985; Jensen & Meckling, 1976; Sheikh et al., 2018; Carpenter & Sanders, 2002). Nonetheless, the majority of the empirical studies on this topic used econometric and statistical methods to explain the factors affecting CEO compensation (Lambert & Larcker, 1987; Jensen & Murphy, 1990; Baber et al., 1998; Murphy, 1999; Leone & Zimmerman, 2006; Gong, 2011; Sun et al., 2013; Nam, 2020). To my knowledge, this study is the first that applies solid geometry functions in this field as a theoretical contribution to tying geometric tools with the principle of "informativeness" proposed by Holmstrom (1979) to provide researchers and policymakers with valuable and relevant information about CEOs. It will allow the application of this type of mathematical instrument to address a range of financial challenges and expand the horizons of accounting and finance. On the other hand, several models underpin the benchmarking of CEO compensation in the literature, each with its theoretical justification and practical application. However, these models are not without critique, reflecting ongoing debates in the field. However, the study provides solutions for some critiques against these models, which will facilitate the process of judging CEO efficiency and choosing the benchmark firm that helps solve overvalued contracts. Moreover, generalizing the equation derived from this research will provide the opportunity to autocorrect CEOs' contracts in the same sector in the future.

Moreover, the derived equation in this study treats the issue of controlling the firm size as used by current existing models (Bizjak et al., 2008; Bebchuk & Fried, 2004; Gabaix &

Landier, 2008; Jensen & Murphy, 1990; Faulkender & Yang, 2010), since firm size has a direct impact on CEO compensation.

Conversely, this study follows the recommendations of (Buzzell et al., 1975) to measure the market share of firm performance, size, and CEO compensation. However, the derived equation is flexible; other transforming techniques, such as the natural logarithm of total assets and CEO compensation, are usable and significant. However, further analysis in the study proves that using the traditional way of measuring CEO compensation, firm size, and performance by the natural logarithm is significant; the Theta index can be calculated using the traditional or market share approach when measuring the predictors. The market share approach proposes a more balanced and multifaceted framework where CEO efficiency is influenced by the combination of firm performance, size, and CEO compensation rather than by firm performance alone. Overall, both approaches offer relevant data but differ in their emphasis. The traditional approach emphasizes the critical role of firm performance. Moreover, this index can avoid the autocorrelation issues when modeling the CEO issues using its predictors; instead, the Theta index includes these predictors in one metric.

On the other hand, according to (Nourayi, 2006; Miller, 2012), CEO compensation practices within the Dow Jones Index do not align with the established theoretical frameworks linking CEO pay to key predictors (firm performance and size). According to their findings, the trends in compensation do not align with the relationship predicted by traditional theories of compensation, such as the pay-for-performance model or the agency theory. The inefficiencies in the current compensation structures, which allow CEOs to receive unusual or irregular compensation regardless of the success of their businesses, are highlighted by this disparity. This inequality can hurt shareholder value, reduce the incentives for good management, and add to the larger problem of CEO overpayment. However, the study indicates that a more logical and performance-driven compensation structure may result from matching CEO compensation to a benchmark value ($\theta$), which is a normative standard established from comparable firms or the marketplace. This benchmark can be used as a guide by peers to create consistent, data-driven pay structures that mirror industry standards and guarantee that CEO compensation is linked to firm performance and shareholder outcomes. This benchmarking method reduces the possibility of rewarding

incompetent CEOs, promotes more equitable compensation practices, and enhances corporate governance. These changes could eventually make compensation more normative, transparent, and justified by coordinating CEO incentives with the long-term increase of shareholder value.

Furthermore, the benchmarking method derived in this study aims to minimize the gap between theories that argue against overpaid CEO compensation, such as agency theory, managerial power theory, and social comparison theory, and those that support higher executive pay, including tournament theory and human capital theory. This approach aims to develop a fair assessment methodology that considers issues with executive compensation's market competitiveness, governance, and justice, through peer pay, conditional on firm size and performance-based criteria. By avoiding excessive compensation unrelated to performance, the benchmarking method guarantees that quantifiable contributions to the success of the company support CEO compensation. It offers a systematic approach that reduces the possibility of self-serving actions and governance failures while maintaining competitive incentives to draw in and keep top executive talent. In order to ensure fair and competitive pay structures, this strategy also recognizes how crucial it is to match compensation with firm attributes like size, industry, and performance market position. Additionally, the benchmarking methodology balances industry standards and organizational pay equality by considering both internal and external factors. It integrates peer-group comparisons to maintain competitive positioning without contributing to pay inflation from unchecked upward benchmarking. Additionally, it employs mechanisms to evaluate long-term value creation, discouraging short-termism and excessive risk-taking, which are common criticisms in CEO pay debates. All things considered, the benchmarking strategy used in the study strikes a balance between incentive alignment, fairness, and market competitiveness. Additionally, it provides a more open and impartial framework for executive pay decisions and narrows the divide between normative and positive approaches of CEO compensation.

The study emphasizes how important it is to enhance the methods used to assess CEO performance, incorporate sound geometry into financial education, and expand the CEO efficiency index for wider applicability. Scholars and experts can enhance corporate

governance, financial modeling, and economic analysis by putting these recommendations into practice. Overall, the study's benchmarking approach balances market competitiveness, fairness, and incentive alignment. It also reduces the gap between normative and positive views on CEO compensation and offers a more transparent and objective framework for executive pay decisions.

The study emphasizes how important it is to enhance the methods used to assess CEO performance, incorporate sound geometry into financial education, and expand the CEO efficiency index for wider applicability. Scholars and professionals can enhance economic analysis, financial modeling, and corporate governance by putting these recommendations into practice. These programs will increase the accuracy of CEO pay plans and give companies and decision-makers more advanced instruments to deal with the intricacies of contemporary economic landscapes. Therefore, this study establishes the foundation for future research to develop financial analysis methods, measurement techniques, and management evaluation in finance and accounting.

### 5.3. Limitations and Methodological Constraints.

Thirty publicly traded companies that are part of the Dow Jones index are included in the study. As a result, choosing these companies ensures that the sample is adequate and representative and permits a thorough analysis of the financial trends and business practices of the market. Moreover, the study covers five years, from 2019 to 2023, and documents management and financial trends before, during, and following major economic events like the COVID-19 pandemic and the ensuing market recovery stages.

Two observations regarding data availability were missing, showing minor anomalies in the dataset. Although the study benefited from a robust dataset of 450 data points from financial reports, five net losses were reported during the study period. The completeness of the data ensures the validity of the study's conclusions in light of this limitation.

This study also represents a new financial and managerial analysis method, as it is the first in the field to use functional solid geometry modeling. This creative approach offers a fresh viewpoint on evaluating CEO performance and company efficiency, which means that previous research has not used the same approach.

One of the main issues the study identified is the substantial difference between the sector's upper and lower edges of CEO efficiency. When users try to modify CEO compensation to match the benchmark firm's, this variation may provide complex figures. However, two ways to address potential biases in remuneration assessments are to hold the CEO to a higher level of performance or directly compare the firm to a more comparable benchmark firm.

Furthermore, the insufficient number of companies listed in Dow Jones, which includes only 30 firms, is considered a significant limitation for conducting a cross-sectional analysis. It is challenging to obtain the statistical power required for trustworthy regression analysis with such a small sample size. This study uses a pooled cross-sectional data approach, which combines observations from several periods, to overcome this limitation and expand the sample size. This method adds more complexity to get objective and reliable estimates in regression models and may conflict with important regression assumptions, including homoscedasticity, independence of observations, and lack of autocorrelation. However, big markets like the S&P 500, FTSE 100, or Russell 3000 typically have enough data over a specific period of time to conduct cross-sectional research without the need for pooling. With a large enough sample size, these marketplaces can easily meet regression assumptions, ensuring more reliable and accurate results. Consequently, although combining cross-sectional data is a valuable approach for researching DJIA, it has methodological limitations that are less common in larger markets where a single-period cross-sectional analysis is adequate to produce reliable statistical results.

Finally, CEO compensation is not typically disclosed as a separate item in the financial statements of most companies listed on the Palestine Exchange. Instead, it is included in the total salary expense for the period in the financial reporting. Because of this lack of disclosure, the study uses an empirical scenario to examine CEO compensation and its implications.

### 5.4. Policy Implications, Recommendations for Policymakers and Practitioners.

In the case of the Dow Jones Index, Home Depot (HD.N) is designated as the benchmark firm for the study period. When using equations to analyze CEO compensation,

researchers should pay close attention to any extraordinary or accidental CEO payments that occur within a specific year. Such inconsistent payments can bias the data and produce an incorrect comparison between competitors and the benchmark firm. Furthermore, delays or deferrals in subsequent CEO compensation could result in disparities when evaluating CEO compensation for a single year. A false impression of overpayment or underpayment during the benchmarking process could arise from these timing problems. To address this issue, it is advised to calculate the average CEO compensation over a number of years rather than relying on a single year's figure. The impact of one-time payments, delays, or scheduling issues is lessened with this multi-year strategy. As a result, the benchmarking approach captures long-term wage fluctuations more accurately and consistently.

Depending on the available firm size and the benchmark value (optimal $\theta$), other peers can either raise performance expectations or modify their CEO compensation to meet benchmark efficiency. Applying pressure to CEO contract design encourages a more significant alignment between CEO compensation and firm size and performance. Specifically, suppose the benchmark $\theta$ indicates that a peer firm achieves superior performance for a comparable level of compensation or company size. In that case, other firms may respond by restructuring their CEO pay packages by reducing base salaries or introducing more performance-based incentives, including stock options or performance bonuses. Instead, without increasing pay, companies could increase the CEO's effectiveness by demanding better performance results, such as increased revenue growth, profitability, or shareholder returns. In addition to helping to curtail CEO compensation practices, this strategy ensures that CEO compensation accurately reflects the creation of shareholder value. Over time, this competitive pressure fosters a more efficient executive labor market as firms strive to balance performance and pay to maintain their standing against benchmarked peers.

The study recommends generalizing the resulting CEO efficiency index to a larger domain to increase its applicability. This index can help markets and economies operate in comparable economic contexts and conditions because of its core value. Applying generalized equations may significantly enhance the accuracy and equity of CEO contracts in both developed and emerging markets. policymakers can create a more flexible, self-correcting system for adjusting executive compensation to reflect changing market

conditions by applying these generalized equations. Using this index will improve corporate governance and provide stability, ensuring that CEO compensation and its determinants have significant relationships (CEO compensation should link to firm size and performance). Therefore, this improvement index and standardization may change corporate governance into a more valuable practice.

Additionally, policymakers can judge workforce investment, talent development, and compensation structures more accurately by including total employee wages and salaries in efficiency assessments. Organizations can enhance resource use, improve strategic planning, and support sustainable growth by viewing human resources as intangible assets rather than merely an annual expense. In addition to strengthening theoretical frameworks in human resource management and accounting, this approach encourages practical implementations that support the economic value of human capital in business and policymaking.

Furthermore, the study recommends that teaching approaches focus on solid geometric concepts to accounting and finance candidate researchers. It handles complicated measurement problems in risk modeling, economic forecasting, and financial analysis. Solid geometry offers crucial tools. Researchers and practitioners can create more accurate models for judging firm performance and examine existing methods and economic forecasts by introducing geometric concepts into financial education. For example, using geometric approaches can improve the accuracy of financial modeling tools that are used to assess market trends, analyze investment risks, and optimize portfolio management strategies. These methods can also help visualize financial data so that multifaceted economic relationships can be interpreted more intuitively. Therefore, including solid geometry into accounting and financial education can give professionals innovative analytical instruments to improve their capacity to handle complex quantitative problems and make better corporate finance decisions. Finally, according to the Palestine exchange, the Theta equation is valuable and provides a benchmark for policymakers, conditional on data availability.

### 5.5. Future Research Direction

Concerned parties can express θ^° in equation (1) using several measurements for firm performance, size, and CEO compensation. While this research uses EPS to express the

firm’s performance, others can use any financial performance metrics, whether accounting or market performance metrics. This study uses total CEO compensation; in contrast, others can separate the total compensation into its components (base, equity compensation, and cash bonus).

Furthermore, future studies can expand by utilizing the CEO efficiency index and investigating other ways to express its main components. One interesting direction for future research is using several indicators to measure CEO performance. Firm performance can be thoroughly evaluated using market-based indicators, such as market capitalization and stock price appreciation, and accounting-based metrics, such as return on equity and assets.

Additionally, firm size as an important determinant of CEO efficiency can be measured through multiple standard metrics, including total revenue, total assets, or market share. Researchers can improve the flexibility of the derived equation of CEO efficiency indices and their adaptability, and guarantee their applicability in various corporate contexts by combining different measuring approaches. With insights that can be adapted to particular industries, organizational structures, and local market situations, this method will enable a more thorough examination of CEO efficiency. However, until this study analysis, the most significant method is the market share of firm performance, size, and CEO compensation.

Researchers may also inquire into different methods of assessing top management efficiency because specific emerging markets do not disclose CEO compensation in a separate item in their financial reports. A more comprehensive assessment can be carried out by looking at the overall pay and salaries of all employees to examine whether evaluating the performance of top management is not possible because of data limitations. This approach offers greater insights into the total efficiency of human capital usage by acting as a stand-in for organizational and workforce productivity. This approach shifts the focus from CEO pay to total labor, enabling a more thorough assessment of HR's impact on business performance. It significantly advances human resource theory by emphasizing the value of assessing human assets rather than merely considering labor costs as an expense. This viewpoint is consistent with the expanding understanding that human capital is an essential intangible asset that supports sustained organizational performance.

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# Appendices

Appendix (1). 2019 Efficiency Ranking

| Efficiency rank | Identifier (RIC) | Year | Comp. | size | Perf. | $\cos\theta^{\circ}$ | $\theta^{\circ}$ degree |
|---|---|---|---|---|---|---|---|
| 1 | HD.N | 2019 | 0.018 | 0.022 | 0.062 | 0.91 | 24.52 |
| 2 | AAPL.OQ | 2019 | 0.018 | 0.015 | 0.043 | 0.88 | 28.58 |
| 3 | CRM.N | 2019 | 0.040 | 0.017 | 0.077 | 0.87 | 29.52 |
| 4 | GS.N | 2019 | 0.038 | 0.018 | 0.066 | 0.84 | 32.38 |
| 5 | IBM.N | 2019 | 0.031 | 0.006 | 0.047 | 0.83 | 33.77 |
| 6 | AXP.N | 2019 | 0.037 | 0.011 | 0.054 | 0.81 | 35.51 |
| 7 | AMGN.OQ | 2019 | 0.030 | 0.003 | 0.030 | 0.70 | 45.70 |
| 8 | CSCO.OQ | 2019 | 0.040 | 0.008 | 0.038 | 0.69 | 46.64 |
| 9 | CAT.N | 2019 | 0.053 | 0.005 | 0.050 | 0.68 | 46.82 |
| 10 | MCD.N | 2019 | 0.027 | 0.011 | 0.026 | 0.67 | 47.88 |
| 11 | AMZN.OQ | 2019 | 0.001 | 0.135 | 0.121 | 0.67 | 48.10 |
| 12 | KO.N | 2019 | 0.029 | 0.037 | 0.037 | 0.62 | 51.54 |
| 13 | CVX.N | 2019 | 0.051 | 0.005 | 0.038 | 0.59 | 53.49 |
| 14 | MMM.N | 2019 | 0.028 | 0.017 | 0.022 | 0.55 | 56.53 |
| 15 | NVDA.OQ | 2019 | 0.018 | 0.014 | 0.015 | 0.55 | 56.76 |
| 16 | MSFT.OQ | 2019 | 0.068 | 0.022 | 0.039 | 0.48 | 61.35 |
| 17 | JPM.N | 2019 | 0.049 | 0.028 | 0.028 | 0.44 | 63.80 |
| 18 | MRK.N | 2019 | 0.043 | 0.012 | 0.021 | 0.43 | 64.81 |
| 19 | TRV.N | 2019 | 0.026 | 0.042 | 0.023 | 0.42 | 65.03 |
| 20 | PG.N | 2019 | 0.032 | 0.038 | 0.023 | 0.41 | 65.56 |
| 21 | DIS.N | 2019 | 0.073 | 0.027 | 0.035 | 0.41 | 65.78 |
| 22 | HON.OQ | 2019 | 0.032 | 0.004 | 0.013 | 0.38 | 67.56 |
| 23 | SHW.N | 2019 | 0.023 | 0.012 | 0.010 | 0.36 | 68.92 |
| 24 | JNJ.N | 2019 | 0.039 | 0.003 | 0.012 | 0.29 | 73.07 |
| 25 | VZ.N | 2019 | 0.028 | 0.049 | 0.014 | 0.24 | 75.82 |
| 26 | UNH.N | 2019 | 0.029 | 0.032 | 0.008 | 0.18 | 79.68 |
| 27 | NKE.N | 2019 | 0.028 | 0.380 | 0.043 | 0.11 | 83.54 |
| 28 | V.N | 2019 | 0.037 | 0.024 | 0.005 | 0.11 | 83.77 |

Appendix (2). 2020 Efficiency Ranking

| Efficiency rank | Identifier (RIC) | Year | Comp. | size | Perf. | cos $\theta^{\circ}$ | $\theta^{\circ}$degree |
|---|---|---|---|---|---|---|---|
| 1 | HD.N | 2020 | 0.017 | 0.007 | 0.050 | 0.94 | 20.00 |
| 2 | UNH.N | 2020 | 0.020 | 0.024 | 0.074 | 0.92 | 22.90 |
| 3 | CAT.N | 2020 | 0.021 | 0.011 | 0.054 | 0.92 | 23.70 |
| 4 | AMGN.OQ | 2020 | 0.031 | 0.008 | 0.072 | 0.91 | 23.92 |
| 5 | MCD.N | 2020 | 0.017 | 0.007 | 0.038 | 0.91 | 25.13 |
| 6 | IBM.N | 2020 | 0.026 | 0.021 | 0.063 | 0.88 | 28.26 |
| 7 | SHW.N | 2020 | 0.024 | 0.003 | 0.034 | 0.82 | 34.67 |
| 8 | TRV.N | 2020 | 0.029 | 0.015 | 0.047 | 0.82 | 35.13 |
| 9 | MMM.N | 2020 | 0.032 | 0.006 | 0.044 | 0.81 | 36.23 |
| 10 | HON.OQ | 2020 | 0.029 | 0.008 | 0.040 | 0.79 | 37.42 |
| 11 | JNJ.N | 2020 | 0.032 | 0.022 | 0.042 | 0.74 | 42.13 |
| 12 | AXP.N | 2020 | 0.037 | 0.027 | 0.040 | 0.65 | 49.16 |
| 13 | MRK.N | 2020 | 0.031 | 0.012 | 0.025 | 0.61 | 52.28 |
| 14 | GS.N | 2020 | 0.037 | 0.137 | 0.103 | 0.59 | 54.19 |
| 15 | PG.N | 2020 | 0.035 | 0.017 | 0.025 | 0.54 | 57.36 |
| 16 | V.N | 2020 | 0.041 | 0.011 | 0.025 | 0.50 | 59.71 |
| 17 | CVX.N | 2020 | 0.045 | 0.033 | 0.031 | 0.48 | 61.11 |
| 18 | VZ.N | 2020 | 0.029 | 0.040 | 0.023 | 0.43 | 64.82 |
| 19 | CSCO.OQ | 2020 | 0.036 | 0.013 | 0.016 | 0.38 | 67.60 |
| 20 | CRM.N | 2020 | 0.040 | 0.008 | 0.015 | 0.34 | 70.12 |
| 21 | KO.N | 2020 | 0.028 | 0.012 | 0.010 | 0.32 | 71.47 |
| 22 | MSFT.OQ | 2020 | 0.077 | 0.042 | 0.028 | 0.31 | 72.16 |
| 23 | AAPL.OQ | 2020 | 0.023 | 0.045 | 0.016 | 0.30 | 72.33 |
| 24 | DIS.N | 2020 | 0.022 | 0.028 | 0.010 | 0.27 | 74.44 |
| 25 | NKE.N | 2020 | 0.042 | 0.004 | 0.008 | 0.18 | 79.60 |
| 26 | WMT.N | 2020 | 0.035 | 0.033 | 0.008 | 0.17 | 80.46 |
| 27 | JPM.N | 2020 | 0.049 | 0.372 | 0.052 | 0.14 | 82.06 |
| 28 | AMZN.OQ | 2020 | 0.055 | 0.031 | 0.006 | 0.09 | 84.94 |

Appendix (3). 2021 Efficiency Ranking

| Efficiency rank | Identifier (RIC) | Year | Comp. | size | Perf. | $\cos\theta^{\circ}$ | $\theta^{\circ}$ degree |
|---|---|---|---|---|---|---|---|
| 1 | HD.N | 2021 | 0.014 | 0.009 | 0.059 | 0.96 | 15.58 |
| 2 | AMGN.OQ | 2021 | 0.022 | 0.008 | 0.082 | 0.96 | 15.69 |
| 3 | UNH.N | 2021 | 0.018 | 0.024 | 0.083 | 0.94 | 20.04 |
| 4 | SHW.N | 2021 | 0.016 | 0.002 | 0.040 | 0.93 | 21.60 |
| 5 | MMM.N | 2021 | 0.018 | 0.006 | 0.043 | 0.91 | 23.85 |
| 6 | TRV.N | 2021 | 0.020 | 0.014 | 0.052 | 0.90 | 25.30 |
| 7 | MRK.N | 2021 | 0.014 | 0.011 | 0.029 | 0.86 | 31.14 |
| 8 | IBM.N | 2021 | 0.017 | 0.019 | 0.043 | 0.86 | 31.22 |
| 9 | MCD.N | 2021 | 0.020 | 0.006 | 0.030 | 0.82 | 35.13 |
| 10 | NKE.N | 2021 | 0.012 | 0.005 | 0.018 | 0.81 | 35.83 |
| 11 | HON.OQ | 2021 | 0.026 | 0.008 | 0.035 | 0.79 | 37.85 |
| 12 | CAT.N | 2021 | 0.024 | 0.010 | 0.032 | 0.78 | 38.86 |
| 13 | JNJ.N | 2021 | 0.029 | 0.021 | 0.040 | 0.74 | 42.64 |
| 14 | PG.N | 2021 | 0.024 | 0.015 | 0.028 | 0.71 | 45.05 |
| 15 | V.N | 2021 | 0.031 | 0.010 | 0.029 | 0.67 | 48.11 |
| 16 | GS.N | 2021 | 0.039 | 0.142 | 0.122 | 0.64 | 50.47 |
| 17 | CRM.N | 2021 | 0.029 | 0.008 | 0.024 | 0.63 | 50.71 |
| 18 | MSFT.OQ | 2021 | 0.055 | 0.041 | 0.040 | 0.50 | 59.86 |
| 19 | CSCO.OQ | 2021 | 0.025 | 0.012 | 0.016 | 0.49 | 60.48 |
| 20 | VZ.N | 2021 | 0.020 | 0.039 | 0.024 | 0.48 | 61.10 |
| 21 | AXP.N | 2021 | 0.025 | 0.023 | 0.019 | 0.47 | 61.75 |
| 22 | KO.N | 2021 | 0.025 | 0.011 | 0.010 | 0.34 | 70.41 |
| 23 | DIS.N | 2021 | 0.032 | 0.025 | 0.011 | 0.27 | 74.55 |
| 24 | AAPL.OQ | 2021 | 0.098 | 0.043 | 0.028 | 0.25 | 75.56 |
| 25 | WMT.N | 2021 | 0.026 | 0.030 | 0.009 | 0.23 | 76.98 |
| 26 | JPM.N | 2021 | 0.084 | 0.415 | 0.044 | 0.10 | 84.09 |
| 27 | NVDA.OQ | 2021 | 0.024 | 0.004 | 0.001 | 0.05 | 87.05 |
| 28 | AMZN.OQ | 2021 | 0.212 | 0.039 | 0.010 | 0.05 | 87.26 |

Appendix (4). 2022 Efficiency Ranking

| Efficiency rank | Identifier (RIC) | Year | Comp. | size | Perf. | Cos $\theta^{\circ}$ | $\theta^{\circ}$ degree |
|---|---|---|---|---|---|---|---|
| 1 | HD.N | 2022 | 0.020 | 0.008 | 0.054 | 0.93 | 21.36 |
| 2 | AMGN.OQ | 2022 | 0.029 | 0.007 | 0.060 | 0.90 | 26.42 |
| 3 | UNH.N | 2022 | 0.028 | 0.023 | 0.067 | 0.88 | 28.60 |
| 4 | MMM.N | 2022 | 0.019 | 0.005 | 0.035 | 0.87 | 29.05 |
| 5 | SHW.N | 2022 | 0.017 | 0.002 | 0.029 | 0.85 | 31.41 |
| 6 | TRV.N | 2022 | 0.029 | 0.013 | 0.049 | 0.84 | 32.72 |
| 7 | MCD.N | 2022 | 0.024 | 0.006 | 0.033 | 0.80 | 37.33 |
| 8 | JNJ.N | 2022 | 0.018 | 0.020 | 0.034 | 0.79 | 37.56 |
| 9 | CAT.N | 2022 | 0.028 | 0.009 | 0.038 | 0.79 | 37.76 |
| 10 | GS.N | 2022 | 0.043 | 0.157 | 0.208 | 0.79 | 38.02 |
| 11 | IBM.N | 2022 | 0.023 | 0.014 | 0.028 | 0.72 | 43.73 |
| 12 | NKE.N | 2022 | 0.013 | 0.004 | 0.013 | 0.68 | 47.14 |
| 13 | HON.OQ | 2022 | 0.035 | 0.007 | 0.028 | 0.63 | 51.26 |
| 14 | MRK.N | 2022 | 0.025 | 0.011 | 0.021 | 0.61 | 52.74 |
| 15 | CVX.N | 2022 | 0.032 | 0.026 | 0.029 | 0.57 | 55.23 |
| 16 | V.N | 2022 | 0.038 | 0.009 | 0.026 | 0.56 | 56.17 |
| 17 | PG.N | 2022 | 0.029 | 0.013 | 0.020 | 0.54 | 57.57 |
| 18 | AXP.N | 2022 | 0.065 | 0.020 | 0.035 | 0.46 | 62.77 |
| 19 | MSFT.OQ | 2022 | 0.066 | 0.039 | 0.032 | 0.39 | 67.15 |
| 20 | CRM.N | 2022 | 0.041 | 0.010 | 0.017 | 0.37 | 68.16 |
| 21 | VZ.N | 2022 | 0.027 | 0.039 | 0.019 | 0.37 | 68.38 |
| 22 | DIS.N | 2022 | 0.033 | 0.022 | 0.012 | 0.30 | 72.58 |
| 23 | CSCO.OQ | 2022 | 0.040 | 0.010 | 0.012 | 0.28 | 73.98 |
| 24 | KO.N | 2022 | 0.031 | 0.010 | 0.008 | 0.24 | 75.99 |
| 25 | WMT.N | 2022 | 0.034 | 0.026 | 0.008 | 0.17 | 80.08 |
| 26 | AMZN.OQ | 2022 | 0.002 | 0.045 | 0.008 | 0.16 | 80.58 |
| 27 | AAPL.OQ | 2022 | 0.135 | 0.038 | 0.021 | 0.15 | 81.31 |
| 28 | JPM.N | 2022 | 0.047 | 0.402 | 0.054 | 0.13 | 82.42 |

Appendix (5). 2023 Efficiency Ranking

| Efficiency rank | Identifier (RIC) | Year | Comp. | size | Perf. | cos $\theta^{\circ}$ | $\theta^{\circ}$ degree |
|---|---|---|---|---|---|---|---|
| 1 | HD.N | 2023 | 0.019 | 0.009 | 0.061 | 0.95 | 19.08 |
| 2 | AMGN.OQ | 2023 | 0.030 | 0.007 | 0.064 | 0.90 | 25.72 |
| 3 | UNH.N | 2023 | 0.031 | 0.027 | 0.081 | 0.89 | 27.29 |
| 4 | MMM.N | 2023 | 0.022 | 0.005 | 0.037 | 0.85 | 31.44 |
| 5 | HON.OQ | 2023 | 0.019 | 0.007 | 0.032 | 0.84 | 32.61 |
| 6 | CVX.N | 2023 | 0.035 | 0.029 | 0.068 | 0.83 | 33.61 |
| 7 | CAT.N | 2023 | 0.034 | 0.009 | 0.052 | 0.82 | 34.48 |
| 8 | MCD.N | 2023 | 0.025 | 0.006 | 0.037 | 0.82 | 35.39 |
| 9 | TRV.N | 2023 | 0.030 | 0.013 | 0.045 | 0.81 | 36.06 |
| 10 | JNJ.N | 2023 | 0.018 | 0.021 | 0.037 | 0.80 | 37.03 |
| 11 | SHW.N | 2023 | 0.026 | 0.003 | 0.032 | 0.78 | 39.07 |
| 12 | IBM.N | 2023 | 0.027 | 0.014 | 0.033 | 0.73 | 42.70 |
| 13 | NKE.N | 2023 | 0.011 | 0.004 | 0.012 | 0.71 | 44.44 |
| 14 | MRK.N | 2023 | 0.027 | 0.012 | 0.027 | 0.68 | 47.42 |
| 15 | V.N | 2023 | 0.035 | 0.010 | 0.032 | 0.66 | 48.49 |
| 16 | AXP.N | 2023 | 0.047 | 0.025 | 0.036 | 0.55 | 56.38 |
| 17 | GS.N | 2023 | 0.035 | 0.161 | 0.109 | 0.55 | 56.47 |
| 18 | PG.N | 2023 | 0.031 | 0.013 | 0.021 | 0.54 | 57.28 |
| 19 | DIS.N | 2023 | 0.020 | 0.023 | 0.014 | 0.41 | 65.80 |
| 20 | VZ.N | 2023 | 0.032 | 0.042 | 0.019 | 0.33 | 70.50 |
| 21 | CRM.N | 2023 | 0.053 | 0.011 | 0.019 | 0.33 | 70.52 |
| 22 | CSCO.OQ | 2023 | 0.042 | 0.011 | 0.014 | 0.31 | 72.12 |
| 23 | MSFT.OQ | 2023 | 0.105 | 0.046 | 0.036 | 0.30 | 72.75 |
| 24 | KO.N | 2023 | 0.033 | 0.010 | 0.009 | 0.25 | 75.35 |
| 25 | AAPL.OQ | 2023 | 0.084 | 0.039 | 0.022 | 0.23 | 76.50 |
| 26 | WMT.N | 2023 | 0.036 | 0.027 | 0.008 | 0.17 | 80.38 |
| 27 | JPM.N | 2023 | 0.047 | 0.409 | 0.044 | 0.11 | 83.92 |
| 28 | NVDA.OQ | 2023 | 0.045 | 0.005 | 0.001 | 0.03 | 88.48 |

Appendix (6). Actual Vs. Adjusted CEO compensation

| Identifier (RIC) | Year | comp | Size | Perf | Actual cosine | Actual degree | adj.cos | adj. degree | adj. comp |
|---|---|---|---|---|---|---|---|---|---|
| SHW.N | 2019 | 0.023 | 0.012 | 0.010 | 0.360 | 68.917 | 0.597 | 53.364 | 0.006 |
| NVDA.OQ | 2019 | 0.018 | 0.014 | 0.015 | 0.548 | 56.759 | 0.597 | 53.364 | 0.014 |
| JNJ.N | 2019 | 0.039 | 0.003 | 0.012 | 0.291 | 73.074 | 0.597 | 53.364 | 0.016 |
| HON.OQ | 2019 | 0.032 | 0.004 | 0.013 | 0.382 | 67.565 | 0.597 | 53.364 | 0.017 |
| MMM.N | 2019 | 0.028 | 0.017 | 0.022 | 0.551 | 56.535 | 0.597 | 53.364 | 0.024 |
| JPM.N | 2019 | 0.049 | 0.028 | 0.028 | 0.441 | 63.804 | 0.597 | 53.364 | 0.024 |
| MRK.N | 2019 | 0.043 | 0.012 | 0.021 | 0.426 | 64.813 | 0.597 | 53.364 | 0.025 |
| MCD.N | 2019 | 0.027 | 0.011 | 0.026 | 0.671 | 47.877 | 0.597 | 53.364 | 0.033 |
| KO.N | 2019 | 0.029 | 0.037 | 0.037 | 0.622 | 51.543 | 0.597 | 53.364 | 0.034 |
| DIS.N | 2019 | 0.073 | 0.027 | 0.035 | 0.410 | 65.784 | 0.597 | 53.364 | 0.039 |
| AMGN.OQ | 2019 | 0.030 | 0.003 | 0.030 | 0.698 | 45.696 | 0.597 | 53.364 | 0.040 |
| MSFT.OQ | 2019 | 0.068 | 0.022 | 0.039 | 0.479 | 61.352 | 0.597 | 53.364 | 0.048 |
| CVX.N | 2019 | 0.051 | 0.005 | 0.038 | 0.595 | 53.491 | 0.597 | 53.364 | 0.051 |
| CSCO.OQ | 2019 | 0.040 | 0.008 | 0.038 | 0.687 | 46.638 | 0.597 | 53.364 | 0.051 |
| AAPL.OQ | 2019 | 0.018 | 0.015 | 0.043 | 0.878 | 28.576 | 0.597 | 53.364 | 0.056 |
| IBM.N | 2019 | 0.031 | 0.006 | 0.047 | 0.831 | 33.770 | 0.597 | 53.364 | 0.063 |
| CAT.N | 2019 | 0.053 | 0.005 | 0.050 | 0.684 | 46.820 | 0.597 | 53.364 | 0.067 |
| AXP.N | 2019 | 0.037 | 0.011 | 0.054 | 0.814 | 35.510 | 0.597 | 53.364 | 0.071 |
| HD.N | 2019 | 0.018 | 0.022 | 0.062 | 0.910 | 24.516 | 0.597 | 53.364 | 0.080 |
| GS.N | 2019 | 0.038 | 0.018 | 0.066 | 0.845 | 32.378 | 0.597 | 53.364 | 0.087 |
| AMZN.OQ | 2019 | 0.001 | 0.135 | 0.121 | 0.668 | 48.097 | 0.597 | 53.364 | 0.091 |
| CRM.N | 2019 | 0.040 | 0.017 | 0.077 | 0.870 | 29.525 | 0.597 | 53.364 | 0.102 |
| KO.N | 2020 | 0.028 | 0.012 | 0.010 | 0.318 | 71.470 | 0.597 | 53.364 | 0.007 |
| NKE.N | 2020 | 0.042 | 0.004 | 0.008 | 0.181 | 79.595 | 0.597 | 53.364 | 0.010 |
| GS.N | 2020 | 0.037 | 0.137 | 0.103 | 0.585 | 54.187 | 0.597 | 53.364 | 0.012 |
| CSCO.OQ | 2020 | 0.036 | 0.013 | 0.016 | 0.381 | 67.595 | 0.597 | 53.364 | 0.016 |
| CRM.N | 2020 | 0.040 | 0.008 | 0.015 | 0.340 | 70.121 | 0.597 | 53.364 | 0.018 |
| CVX.N | 2020 | 0.045 | 0.033 | 0.031 | 0.483 | 61.108 | 0.597 | 53.364 | 0.025 |
| PG.N | 2020 | 0.035 | 0.017 | 0.025 | 0.539 | 57.364 | 0.597 | 53.364 | 0.029 |
| V.N | 2020 | 0.041 | 0.011 | 0.025 | 0.504 | 59.708 | 0.597 | 53.364 | 0.031 |
| MRK.N | 2020 | 0.031 | 0.012 | 0.025 | 0.612 | 52.276 | 0.597 | 53.364 | 0.032 |
| SHW.N | 2020 | 0.024 | 0.003 | 0.034 | 0.822 | 34.667 | 0.597 | 53.364 | 0.046 |
| AXP.N | 2020 | 0.037 | 0.027 | 0.040 | 0.654 | 49.160 | 0.597 | 53.364 | 0.046 |
| MCD.N | 2020 | 0.017 | 0.007 | 0.038 | 0.905 | 25.129 | 0.597 | 53.364 | 0.051 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| JNJ.N | 2020 | 0.032 | 0.022 | 0.042 | 0.742 | 42.134 | 0.597 | 53.364 | 0.053 |
| HON.OQ | 2020 | 0.029 | 0.008 | 0.040 | 0.794 | 37.419 | 0.597 | 53.364 | 0.053 |
| MMM.N | 2020 | 0.032 | 0.006 | 0.044 | 0.807 | 36.225 | 0.597 | 53.364 | 0.059 |
| TRV.N | 2020 | 0.029 | 0.015 | 0.047 | 0.818 | 35.133 | 0.597 | 53.364 | 0.061 |
| HD.N | 2020 | 0.017 | 0.007 | 0.050 | 0.940 | 19.995 | 0.597 | 53.364 | 0.067 |
| CAT.N | 2020 | 0.021 | 0.011 | 0.054 | 0.916 | 23.695 | 0.597 | 53.364 | 0.072 |
| IBM.N | 2020 | 0.026 | 0.021 | 0.063 | 0.881 | 28.257 | 0.597 | 53.364 | 0.081 |
| UNH.N | 2020 | 0.020 | 0.024 | 0.074 | 0.921 | 22.903 | 0.597 | 53.364 | 0.096 |
| AMGN.OQ | 2020 | 0.031 | 0.008 | 0.072 | 0.914 | 23.916 | 0.597 | 53.364 | 0.097 |
| KO.N | 2021 | 0.025 | 0.011 | 0.010 | 0.335 | 70.411 | 0.597 | 53.364 | 0.007 |
| AXP.N | 2021 | 0.025 | 0.023 | 0.019 | 0.473 | 61.750 | 0.597 | 53.364 | 0.009 |
| CSCO.OQ | 2021 | 0.025 | 0.012 | 0.016 | 0.493 | 60.484 | 0.597 | 53.364 | 0.018 |
| NKE.N | 2021 | 0.012 | 0.005 | 0.018 | 0.811 | 35.830 | 0.597 | 53.364 | 0.023 |
| CRM.N | 2021 | 0.029 | 0.008 | 0.024 | 0.633 | 50.714 | 0.597 | 53.364 | 0.032 |
| MSFT.OQ | 2021 | 0.055 | 0.041 | 0.040 | 0.502 | 59.861 | 0.597 | 53.364 | 0.034 |
| PG.N | 2021 | 0.024 | 0.015 | 0.028 | 0.706 | 45.050 | 0.597 | 53.364 | 0.035 |
| MRK.N | 2021 | 0.014 | 0.011 | 0.029 | 0.856 | 31.139 | 0.597 | 53.364 | 0.038 |
| V.N | 2021 | 0.031 | 0.010 | 0.029 | 0.668 | 48.105 | 0.597 | 53.364 | 0.038 |
| MCD.N | 2021 | 0.020 | 0.006 | 0.030 | 0.818 | 35.125 | 0.597 | 53.364 | 0.040 |
| CAT.N | 2021 | 0.024 | 0.010 | 0.032 | 0.779 | 38.856 | 0.597 | 53.364 | 0.042 |
| HON.OQ | 2021 | 0.026 | 0.008 | 0.035 | 0.790 | 37.847 | 0.597 | 53.364 | 0.046 |
| JNJ.N | 2021 | 0.029 | 0.021 | 0.040 | 0.736 | 42.635 | 0.597 | 53.364 | 0.049 |
| IBM.N | 2021 | 0.017 | 0.019 | 0.043 | 0.855 | 31.221 | 0.597 | 53.364 | 0.054 |
| SHW.N | 2021 | 0.016 | 0.002 | 0.040 | 0.930 | 21.599 | 0.597 | 53.364 | 0.054 |
| MMM.N | 2021 | 0.018 | 0.006 | 0.043 | 0.915 | 23.851 | 0.597 | 53.364 | 0.058 |
| TRV.N | 2021 | 0.020 | 0.014 | 0.052 | 0.904 | 25.298 | 0.597 | 53.364 | 0.068 |
| HD.N | 2021 | 0.014 | 0.009 | 0.059 | 0.963 | 15.581 | 0.597 | 53.364 | 0.079 |
| GS.N | 2021 | 0.039 | 0.142 | 0.122 | 0.636 | 50.474 | 0.597 | 53.364 | 0.081 |
| UNH.N | 2021 | 0.018 | 0.024 | 0.083 | 0.939 | 20.044 | 0.597 | 53.364 | 0.109 |
| AMGN.OQ | 2021 | 0.022 | 0.008 | 0.082 | 0.963 | 15.689 | 0.597 | 53.364 | 0.110 |
| KO.N | 2022 | 0.031 | 0.010 | 0.008 | 0.242 | 75.989 | 0.597 | 53.364 | 0.004 |
| CSCO.OQ | 2022 | 0.040 | 0.010 | 0.012 | 0.276 | 73.976 | 0.597 | 53.364 | 0.012 |
| NKE.N | 2022 | 0.013 | 0.004 | 0.013 | 0.680 | 47.144 | 0.597 | 53.364 | 0.017 |
| MSFT.OQ | 2022 | 0.066 | 0.039 | 0.032 | 0.388 | 67.151 | 0.597 | 53.364 | 0.019 |
| CRM.N | 2022 | 0.041 | 0.010 | 0.017 | 0.372 | 68.161 | 0.597 | 53.364 | 0.020 |
| PG.N | 2022 | 0.029 | 0.013 | 0.020 | 0.536 | 57.565 | 0.597 | 53.364 | 0.024 |
| MRK.N | 2022 | 0.025 | 0.011 | 0.021 | 0.605 | 52.740 | 0.597 | 53.364 | 0.026 |
| CVX.N | 2022 | 0.032 | 0.026 | 0.029 | 0.570 | 55.231 | 0.597 | 53.364 | 0.028 |
| V.N | 2022 | 0.038 | 0.009 | 0.026 | 0.557 | 56.175 | 0.597 | 53.364 | 0.034 |
| IBM.N | 2022 | 0.023 | 0.014 | 0.028 | 0.723 | 43.734 | 0.597 | 53.364 | 0.035 |
| HON.OQ | 2022 | 0.035 | 0.007 | 0.028 | 0.626 | 51.259 | 0.597 | 53.364 | 0.037 |
| SHW.N | 2022 | 0.017 | 0.002 | 0.029 | 0.853 | 31.413 | 0.597 | 53.364 | 0.038 |

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|---|---|---|---|---|---|---|---|---|---|
| JNJ.N | 2022 | 0.018 | 0.020 | 0.034 | 0.793 | 37.563 | 0.597 | 53.364 | 0.042 |
| AXP.N | 2022 | 0.065 | 0.020 | 0.035 | 0.458 | 62.772 | 0.597 | 53.364 | 0.043 |
| MCD.N | 2022 | 0.024 | 0.006 | 0.033 | 0.795 | 37.325 | 0.597 | 53.364 | 0.043 |
| MMM.N | 2022 | 0.019 | 0.005 | 0.035 | 0.874 | 29.050 | 0.597 | 53.364 | 0.047 |
| CAT.N | 2022 | 0.028 | 0.009 | 0.038 | 0.791 | 37.759 | 0.597 | 53.364 | 0.050 |
| TRV.N | 2022 | 0.029 | 0.013 | 0.049 | 0.841 | 32.716 | 0.597 | 53.364 | 0.064 |
| HD.N | 2022 | 0.020 | 0.008 | 0.054 | 0.931 | 21.361 | 0.597 | 53.364 | 0.073 |
| AMGN.OQ | 2022 | 0.029 | 0.007 | 0.060 | 0.896 | 26.418 | 0.597 | 53.364 | 0.080 |
| UNH.N | 2022 | 0.028 | 0.023 | 0.067 | 0.878 | 28.598 | 0.597 | 53.364 | 0.087 |
| GS.N | 2022 | 0.043 | 0.157 | 0.208 | 0.788 | 38.019 | 0.597 | 53.364 | 0.232 |
| KO.N | 2023 | 0.033 | 0.010 | 0.009 | 0.253 | 75.353 | 0.597 | 53.364 | 0.006 |
| MSFT.OQ | 2023 | 0.105 | 0.046 | 0.036 | 0.297 | 72.745 | 0.597 | 53.364 | 0.013 |
| NKE.N | 2023 | 0.011 | 0.004 | 0.012 | 0.714 | 44.439 | 0.597 | 53.364 | 0.015 |
| CSCO.OQ | 2023 | 0.042 | 0.011 | 0.014 | 0.307 | 72.124 | 0.597 | 53.364 | 0.015 |
| CRM.N | 2023 | 0.053 | 0.011 | 0.019 | 0.333 | 70.522 | 0.597 | 53.364 | 0.023 |
| PG.N | 2023 | 0.031 | 0.013 | 0.021 | 0.541 | 57.282 | 0.597 | 53.364 | 0.025 |
| MRK.N | 2023 | 0.027 | 0.012 | 0.027 | 0.677 | 47.416 | 0.597 | 53.364 | 0.034 |
| AXP.N | 2023 | 0.047 | 0.025 | 0.036 | 0.554 | 56.385 | 0.597 | 53.364 | 0.041 |
| V.N | 2023 | 0.035 | 0.010 | 0.032 | 0.663 | 48.488 | 0.597 | 53.364 | 0.042 |
| HON.OQ | 2023 | 0.019 | 0.007 | 0.032 | 0.842 | 32.612 | 0.597 | 53.364 | 0.042 |
| IBM.N | 2023 | 0.027 | 0.014 | 0.033 | 0.735 | 42.696 | 0.597 | 53.364 | 0.042 |
| SHW.N | 2023 | 0.026 | 0.003 | 0.032 | 0.776 | 39.071 | 0.597 | 53.364 | 0.043 |
| JNJ.N | 2023 | 0.018 | 0.021 | 0.037 | 0.798 | 37.035 | 0.597 | 53.364 | 0.045 |
| MCD.N | 2023 | 0.025 | 0.006 | 0.037 | 0.815 | 35.394 | 0.597 | 53.364 | 0.049 |
| MMM.N | 2023 | 0.022 | 0.005 | 0.037 | 0.853 | 31.442 | 0.597 | 53.364 | 0.049 |
| TRV.N | 2023 | 0.030 | 0.013 | 0.045 | 0.808 | 36.058 | 0.597 | 53.364 | 0.059 |
| CAT.N | 2023 | 0.034 | 0.009 | 0.052 | 0.824 | 34.476 | 0.597 | 53.364 | 0.069 |
| HD.N | 2023 | 0.019 | 0.009 | 0.061 | 0.945 | 19.083 | 0.597 | 53.364 | 0.081 |
| AMGN.OQ | 2023 | 0.030 | 0.007 | 0.064 | 0.901 | 25.720 | 0.597 | 53.364 | 0.086 |
| CVX.N | 2023 | 0.035 | 0.029 | 0.068 | 0.833 | 33.606 | 0.597 | 53.364 | 0.087 |
| UNH.N | 2023 | 0.031 | 0.027 | 0.081 | 0.889 | 27.294 | 0.597 | 53.364 | 0.105 |

# نحو تعويضات معيارية للمدير التنفيذي: مقارنة رياضية

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## ملخص

تستخدم الدراسة نمذجة الهندسة الصلبة لتطوير معادلة رياضية مصممة لتوليد مؤشر غني بالمعلومات حول كفاءة الرئيس التنفيذي. يعمل هذا المؤشر كأداة تحليلية حاسمة تدمج ثلاثة متغيرات رئيسية( أداء الشركة وحجم الشركة وتعويضات الرئيس التنفيذي) ضمن فراغ ثلاثي الأبعاد. وبالتالي، توفر المعادلة نهجًا منظمًا لقياس العلاقة بين هذه المتغيرات، مما يوفر فهمًا أوضح لكيفية توافق أجر الرئيس التنفيذي مع نجاح الشركة وحجمها. ينبع الأساس النظري الأساسي لهذه المعادلة من دمج مبدأ المعلوماتية مع النمذجة الرياضية المتقدمة. يسمح هذا الاندماج بتحديد أكثر دقة لتعويضات الرئيس التنفيذي المعيارية، لأنه يسهل مقارنة كفاءة الرئيس التنفيذي بأقرانه في نفس القطاع. يساعد هذا النهج في تحسين هياكل أجور المديرين التنفيذيين من خلال ضمان ربط التعويضات بمقاييس الأداء الفعلية بدلاً من المعايير التعسفية أو غير المتسقة.

وعلاوة على ذلك، تختبر الدراسة بدقة صحة هذه المعادلة من خلال تطبيقها على الشركات المدرجة في سوق داو جونز على مدى خمس سنوات من 2019 إلى 2023. يتيح هذا التطبيق التجريبي للدراسة

تقييم دقة المعادلة التنبؤية وموثوقيتها في سيناريوهات العالم الحقيقي. ومن خلال اختبارات التحقق، تؤكد الدراسة أن المعادلة تلتقط بفعالية الاختلافات في كفاءة الرئيس التنفيذي وتوفر رؤى مفيدة حول هياكل التعويضات التنفيذية. واستناداً إلى هذه النتائج، توصي الدراسة بقوة بتوسيع نطاق استخدام هذه المعادلة خارج عينة داو جونز إلى مجموعة أوسع من الصناعات وسياقات السوق. ومن الممكن أن يؤدي تعميم تطبيق هذا النموذج إلى تعزيز ممارسات تحديد معايير التعويضات عبر بيئات الشركات المختلفة. وبالإضافة إلى ذلك، تشجع الدراسة الباحثين والمحللين الماليين على استكشاف المزيد من استخدام النمذجة الرياضية من خلال الهندسة الصلبة كأداة رياضية قوية. وتتمتع هذه النمذجة بإمكانية معالجة تحديات القياس المختلفة التي تواجهها البحوث المالية والإدارية بشكل شائع، وخاصة في المجالات التي تتطلب تحليلاً دقيقاً ومتعدد الأبعاد. ومن خلال الاستفادة من نمذجة الهندسة الصلبة، يمكن للدراسات المستقبلية تطوير منهجيات أكثر دقة وتطوراً لتقييم أداء المديرين التنفيذيين ومواءمة التعويضات.

الكلمات المفتاحية: تعويضات المدير التنفيذي, مقارنة المدراء التنفيذيين, كفاءة المدير التنفيذي, الهندسة الصلبة.