An Application Of Data Envelopment Analysis To Benchmark CEO Remuneration: A South African Study

Marli Theunissen, North-West University, South Africa
Merwe Oberholzer, North-West University, South Africa

ABSTRACT

The purpose of the study is twofold; firstly, to use data envelopment analysis (DEA) to estimate the technical efficiencies of Johannesburg Stock Exchange (JSE)-listed companies (per industry) to convert the multiple components of CEO remuneration into multiple company determinants, namely size and performance indicators, and secondly, to develop an efficiency frontier to serve as a benchmark to suggest acceptable CEO remuneration levels. An empirical study was executed on a sample of 221 JSE-listed companies. Cross-sectional data of CEO remuneration and company determinants were obtained from the McGregor BFA database for the 2010 financial year. The study found that CEOs from 80 of the 221 companies included in the sample emerged as the benchmark CEOs and formed the efficiency frontier against which inefficient CEOs were compared. The practical value is that remuneration committees can use this model, which is based on best practices, to simplify the structuring of reasonable CEO remuneration packages.

Keywords: Data Envelopment Analysis (DEA); Chief Executive Officers (CEO); Remuneration; Benchmark

INTRODUCTION

Excessive remuneration packages of CEOs in South Africa recently became widely publicized and subjected to public scrutiny (Finweek, 2012; Ensor, 2010; Financial Mail, 2008) with the concern is that CEOs are remunerating themselves at the expense of shareholders' interests and the long-term success of the company (BPP Learning Media, 2010). Furthermore, the gap between CEO salaries and the average wage of an ordinary worker is continuously increasing (Sapa, 2011). This study is an attempt to develop and validate benchmarks for CEO remuneration of companies listed on the different industries of the Johannesburg Stock Exchange (JSE). A data envelopment analysis (DEA) model is developed to generate expected remuneration values that are compared with actual remuneration. The practical value of this study is the setting of new parameters for CEO remuneration in South Africa. The importance thereof is that the results can assist company boards of directors in making informed business decisions in this regard.

In South Africa, research has been conducted by a number of institutes and individuals. For example, Adcorps' new quarterly *Labour Market Navigator* analyzed JSE-listed companies and made public the results regarding the over- or underpaying of CEOs (Finweek, 2012). Other South African researchers are Bradley (2011), Dommisse (2011), Theunissen (2010) and Krugel and Kruger (2006), but a limitation of these researchers' studies is that no benchmarking model, based on best practices, was suggested to determine acceptable levels of CEO remuneration. All the above-mentioned studies analyzed CEO remuneration by means of a two-dimensional statistical model, namely the linear regression analysis, which is based on averages and fails to indicate an appropriate level of inputs or outputs that will represent an optimal solution (Thanassoulis, 1993).

A recent article in Business Report announced that Bobby Godsell, chairman of Business Leadership SA, has called for a commission on high pay to be established in South Africa, similar to the UK's High Pay Commission (Crotty, 2012). Also in this regard, Gerald Seegers, South African partner of PricewaterhouseCoopers, is of the opinion that new executive reward models are required that can be tailored to specific businesses that are both relevant and simple in terms of design and number of elements. He continued that existing executive pay models have largely failed in two aspects: i) serving as a motivational tool, and ii) establishing goal congruence between executives and shareholders (PwC, 2010). What is needed is a business-specific, multi-element model to benchmark CEO remuneration and therefore a simple two-dimensional model will not suffice. CEO remuneration, consisting of multiple components (a basic salary, short- and long-term incentives), has to be benchmarked within the context of the different factors, e.g. company size and performance (Cordeiro *et al*., 2006), on which the basic salary and additional incentives are based. An acceptable benchmarking model is therefore needed to firstly determine whether a particular CEO is being over- or underpaid within the context of business specific elements and secondly, the model should be able to indicate an acceptable level of remuneration. The DEA may provide a potential benchmarking model. It is a linear programming technique that allows relative efficiency to be defined in terms of multiple inputs and outputs (Paradi *et al*., 2010). Only four previous studies could be identified that combine the DEA with CEO remuneration. The first two studies, by Mohan and Ruggiero (2003) and Bowlin and Renner (2008), used DEA to study gender equity in top-management-team compensation. The following two studies, which are most relevant to the current study, are by Cordeiro *et al.* (2006), which pointed out the shortcomings of traditional parametric approaches, such as regression analysis, when analyzing CEO remuneration practices by using an input-orientated approach. Total (aggregated) CEO Remuneration was the only input to their model and various measures of company size and performance were used as the outputs. The other study, by Oberholzer and Theunissen (2012), investigated 187 JSE companies and compared CEO remuneration where benchmarks were determined by an input-orientated DEA model (where total (aggregated) remuneration was the only input variable), versus a linear regression analysis model. To summarize, the gap in the literature is that no research has been conducted where the multiple CEO remuneration components were disaggregated, where both an input- and output-orientation approach were used and the benchmarks, based on best practices, were set for the different industries.

The purpose of the study is twofold; firstly, to estimate input- and output-orientated technical efficiencies of all JSE-listed companies (per industry) to convert the multiple components of CEO remuneration into a number of company determinants, and secondly, to develop an efficiency frontier to serve as a benchmark to suggest acceptable CEO remuneration levels based on a company's performance indicators as defined in the DEA model. To fulfill the purpose, an empirical study was executed on a sample of 221 JSE-listed companies to estimate the above-mentioned technical efficiencies and to develop an efficiency frontier (best practice frontier) to serve as a benchmark for CEO remuneration in the different industries. Cross-sectional data of CEO remuneration and company determinants were obtained from the McGregor BFA (2012) database for the 2010 financial year. The central argument is that DEA is the most suitable model that can set separate benchmarks for multiple CEO remuneration components (inputs) and benchmarks for multiple company determinants (outputs).

The contribution of this study is twofold: From a research perspective, it contributes to the advancement of CEO remuneration research by introducing an alternative, multi-dimensional model by which CEO remuneration can be analyzed; and from a practitioner's perspective, boards of directors can justify the level of remuneration paid to CEOs in terms of the company's size and performance by applying the DEA. This model also provides a benchmark for CEO remuneration in terms of the inputs and outputs defined. The DEA could be used as a guide to determine acceptable remuneration levels that may decrease the gap between CEO remuneration and that of the average worker.

The remainder of the paper is organized as follows: The next section provides a background to the study, followed by a section that explains the theory, i.e. the business factors and the DEA model, and a section that explains the research methodology. This is followed by a section that reveals the results and the study is concluded in the final section.

BACKGROUND

CEO remuneration is excessively high and could be linked to several factors that contributed to these pay hikes. Three of these factors are briefly discussed below. Firstly, recent investigations revealed that CEOs made millions when they exercised their share options. The size of the gain mainly depends on the number of share options and the prevailing share price on the date the option is exercised. To a certain extent, a CEO can influence the share price through good governance, but there are also uncontrollable market factors that can influence the share price. This fuels the argument that CEOs reap the benefits of an increased share price, while the increase was due to market factors and not so much to their own contribution (Financial Mail, 2008).

A second contributing factor to the pay hikes is the discrepancy between pay and performance. Former South African finance minister, Trevor Manuel, reported that government is concerned as ever about pay levels, especially where there is no relation to the performance of the company (Financial Mail, 2008). The current South African finance minister, Pravin Gordhan, shares this view by saying that extreme earning disparities cause offence not just when they are associated with profiteering or financial malfeasance, but also when the reward for honest work seems disproportionate or weakly aligned with incentives (Ensor, 2010).

A third possible cause of pay hikes, examined by Hayes and Schaefer (2007), is known as the 'Lake Wobegon Effect'. Gareth Keillor, radio host and humorist, refers to a fictional hometown, Lake Wobegon, where every child is above average. This also seems to be the case with CEOs, where companies are prepared to pay ever-increasing salaries to convince shareholders that their CEO is above average, because this makes the company look strong. Most boards want their CEO to be in the top half of the CEO peer group. Therefore, when another CEO obtains a raise, their CEO gets one too, even if s/he had a bad year (Hayes & Schaefer, 2007).

To complicate things, CEO remuneration consists of multiple components (inputs), and on the other hand, the CEO should be remunerated for multiple company determinants (outputs), such as company size and performance. Therefore, the conceptual scope of the study is that a model that can accommodate multiple inputs and outputs should be used to set a separate benchmark for each variable, i.e. from an input-orientated view, a benchmark can be set for each remuneration component and, from an output-orientated view, a benchmark can be set regarding each company determinant.

THEORY

This section focuses on three aspects, namely the components of CEO remuneration, the determinants for CEO remuneration and an in-depth explanation of DEA. Remuneration practices vary substantially across companies and industries, but mostly CEO remuneration will contain the following components: Salary, benefits and pension, annual bonus, share options and long-term incentive plans (Yanadori *et al.*, 2002; Frydman & Jenter, 2010).

Two determinants of CEO remuneration are included in the study, namely company performance and company size. According to Murphy (1999), CEO wealth is explicitly tied to the shareholder's objective (creation of shareholder wealth) through his/her holdings of share, restricted share, and share options. In addition, CEO wealth is implicitly tied to share-price performance through accounting-based bonuses (reflecting the correlation between accounting returns and share price performance) and through year-to-year adjustments in salary levels, target bonuses, and option and restricted share grant sizes. Therefore, payouts should be positively related to the shareholder's objective (increasing shareholder wealth) and to other measures, like accounting measures of firm performance, that provide imperfect incentives to the CEO to take actions generally consistent with value maximization.

The effect of an increase in company size on CEO remuneration is frequently investigated in CEO remuneration research. Devers *et al.* (2007) report that a meta-analysis in the area of CEO remuneration research demonstrated that company size accounted for over 40% of the variance in total CEO remuneration. Researchers make several suggestions as to why larger companies might have higher CEO remuneration levels: Larger firms may employ better-qualified and better-paid managers (Murphy, 1999), have more operations, subsidiaries and layers of management (Lippert & Moore, 1994), require a higher level of responsibility and have more complex tasks and therefore place greater value on decision-making (Janssen, 2009).

Data Envelopment Analysis

The concept of establishing a satisfactory measure for productive efficiency that takes account of all inputs was first introduced by Farrell (1957). The DEA model was later developed and formalized by Charnes *et al.* (1978)

in response to the challenge laid down by Farrell, which was to estimate the production function either through a parametric approach or by using non-parametric linear technology (Avkiran & Rowlands, 2008). The most comprehensive definition of the DEA is that it is a non-parametric linear programming technique that computes a comparative ratio of outputs to inputs for each unit, which is reported as the relative efficiency score (Avkiran, 1999). (Unit refers to a decision-making unit, i.e. company with regard to this study). It creates a frontier of the best performing units within the dataset (Bowlin & Renner, 2008), which consists of units that possess some common functional traits, but whose efficiency may vary due to internal differences (El-Mahgary & Lahdelma, 1995). Its main usefulness lies in its ability to identify units to benchmark against and to generate potential improvements for inefficient units (Avkiran, 1999).

The DEA allows the analyst to select multiple inputs and outputs in accordance with a managerial focus and it can work with variables of different units without the need for standardization (i.e. monetary value, percentage, number of employees, etc.). This process involves identifying performance variables (outputs) that reflect the corporate objectives and strategies of the company and then determining the input variables that can be demonstrated to manifest themselves as outputs (Avkiran, 1999). This characteristic is especially useful in this study where there are multiple CEO remuneration components (inputs) and determinants (outputs) to consider. Furthermore, there are no multi-co linearity problems with the DEA like there are with regression analysis, so variables that measure similar CEO or company characteristics (determinants) can be used simultaneously in the model (Bowlin & Renner, 2008). Another common practice in DEA is to allow the optimization programme to determine the weights for each variable included in the model. However, it is possible to restrict the weight of variables if management is concerned that a variable might be under- or over-represented (Avkiran, 1999).

The analyst also has the model options of input minimization and output maximization with the DEA. Input minimization (input-orientated approach) examines the extent to which inputs can be reduced while maintaining output levels. Potential improvements indicated by the DEA may suggest increasing outputs and lowering inputs at the same time if output slacks depict under-produced outputs. Alternatively, output maximization (output-orientated approach) investigates the extent to which outputs can be raised given current input levels.

The efficiency frontier, or envelope, is the foundation for the whole concept of DEA. The DEA identifies inefficiency in a particular unit by comparing it to similar units regarded as efficient (Avkiran, 1999). If a given producer, A, is capable of producing Y_A units of output with X_A inputs, then other producers should also be able to do the same if they were to operate efficiently. Similarly, if producer B is capable of producing Y_B units of output with X_B inputs, then other producers should also be capable of the same production schedule (Anderson, 1996). Producers A and B can be combined to form a hypothetical unit that is constructed as a weighted average of the two observed units (reference set). Anderson (1996) states that the heart of the DEA lies in finding the 'best' virtual unit for each real unit. If the virtual unit is better than the original unit by generating more output with the same input or generating the same output with less input, the original unit is inefficient. This way the DEA can also be used to benchmark the best practice in a particular group of units (Avkiran, 1999). If the analyst knows which efficient units are most comparable to the inefficient unit, they will develop a better understanding of the nature of the inefficiencies and can re-allocate scarce resources in order to improve productivity (Avkiran, 1999).

Another feature of the DEA, for which the analyst should make some assumptions, regards the nature of returns to scale that best reflect the operations of the units in the sample. The two types of returns to scale to consider are constant returns to scale (CRS) or variable returns to scale (VRS). CRS implies a proportionate rise in outputs when inputs are increased. In this case, the scale of operations does not influence the efficiency of the unit. VRS implies a disproportionate rise or fall in outputs when inputs are increased. This means that as a unit grows in size, its efficiency would either rise or fall (Avkiran, 1999).

The most important limitation of the DEA is that it assumes data to be free of measurement error. If the integrity of data has been violated, DEA results cannot be interpreted with confidence because the efficiency scores of units both on and under the frontier will be biased. A second limitation of the DEA is that those units indicated as efficient are only efficient in relation to others inside the sample (Avkiran, 1999). Thirdly, the DEA is a good indicator of relative efficiency, but not absolute efficiency. In other words, it indicates how well a unit is doing compared to its peers, but not compared to a theoretical maximum (Anderson, 1996). Furthermore, the DEA will not discriminate well if the ratio of units to the product of inputs and outputs is low, because most units would simply appear as efficient and lie on the frontier (Avkiran, 1999). To summarize, DEA is a useful tool in setting targets for inefficient units to improve performance, but the drawback is that it does not indicate to the analyst how to reach those targets or why the unit is not performing well. The reference set is a good starting point, but further analysis is necessary to identify specific problems within a unit.

METHOD

In this study, CEO remuneration components will be the inputs and business determinants will be the outputs of the DEA model. The input-orientated approach will be used to indicate by how much CEO remuneration can be reduced while maintaining a certain level of company performance and size. The output-orientated approach will also be used to indicate what level of company performance or size justifies the current CEO remuneration level.

Variable Description

In Table 1, the inputs to the DEA model represent the components of CEO remuneration (X_1, X_2, X_3, X_4), which are in accordance with the terms and classification used in the McGregor BFA (2012). This multiple classification allows for more accurate benchmarking because it makes it possible to pinpoint which component has to be increased or reduced to improve the efficiency score of a CEO rather than just suggesting an increase or reduction of total CEO remuneration.

Table 1: Input and Output Measures

	Symbol	**Concept**	**Measure**
Inputs: Remuneration Components	X_1	Base Pay	'Salary'
	X_2	Perquisites and Pension	Total of 'Retirement and/or Medical' contributions, 'Allowances and Benefits', 'Motor and Travel' allowances and 'Fee/Levy Payment'
	X_3	Annual Bonus Plans	Total of 'Bonus paid in current year', 'Performance Bonus', 'Other Benefits' and "Once off Payments'
	X_4	Long-term Incentives	'Gains on Shares'
Outputs: Determinants	Y_1	Company Performance	Return on Equity
	Y_2	Company Size	Total Assets (Including intangible assets)

Source: Classification used in the McGregor BFA database

Also in Table 1 are the outputs to the DEA model, which represent the determinants of CEO remuneration (Y_1, Y_2). 'Company Performance' is measured in terms of Return on Equity (ROE). ROE can be disaggregated using the DuPont Analysis, where this disaggregation facilitates the examination of ROE in terms of a measure for profitability (Net Income ÷ Sales), level of assets required to generate sales (Sales ÷ Total Assets) and the financing of those assets (Total Assets ÷ Equity) (Feroz *et al.*, 2003). ROE is therefore a suitable measure for company performance because it encompasses three dimensions (profit margins, asset utilization and financing) that are all affected by the CEO's actions and decisions. Following Oberholzer and Theunissen (2012), Theunissen (2010), Bowlin and Renner (2008), Chen *et al.* (2008), Total Assets was chosen as a measure for 'Company Size' as shown in Table 1, because it represents managerial concern with company growth and size. The value of Total Assets used in this study includes intangible assets to account for the size of companies that own non-monetary assets without physical substance such as intellectual or human capital.

Sample Statistics

The McGregor BFA (2012) database was used to gather financial and CEO remuneration data for JSE-listed companies with financial year ends during 2010. The initial dataset consisted of 359 companies, but companies that did not provide CEO remuneration data were eliminated because the data could not be manually retrieved from the annual reports in the same format as the McGregor BFA (2012). Furthermore, since the software of Zhu (2004) used in this analysis only accepts positive data, companies with negative financial data were also eliminated. After elimination of the above-mentioned companies, the final sample consists of 221 companies across nine different industries. Following Cordeiro *et al.* (2006), each industry will be analyzed separately with the DEA to account for the variation across industries. Table 2 summarizes the number of companies in the sample and different industries:

Table 2: Sample Statistics

Sample	n	Industry	n
Companies	221	Basic Materials	41
CEOs	221	Consumer Goods	20
Industries	9	Consumer Services	33
		Financials	48
		Health Care	5
		Industrials	57
		Oil & Gas	1
		Technology	11
		Telecommunications	5
		Total	**221**

Source: McGregor BFA

In order to discriminate well between the efficient and inefficient CEOs, the sample size has to be at least three times larger than the sum of the number of inputs and outputs (Avkiran, 1999). Therefore, a sample size of at least 18 companies in each industry ((4 inputs + 2 outputs = 6) x 3 = 18) is required to analyze it separately. Table 2 indicates that the Healthcare, Oil and Gas, and Technology and Telecommunications industries have fewer than 18 companies and can therefore not be analyzed separately. In order to include these companies in the analysis, these industries were joined with industries of a similar kind to obtain a sample of 18 or more companies. Oil and Gas was joined with Basic Materials, while Healthcare, and Technology and Telecommunications were joined together since all three of these industries involve some form of technology, technological equipment or technology-related services. Since the year-end dates of the companies differ, all the monetary values in the dataset were adjusted with the Producer Price Index (PPI) factor. December 2010 was chosen as the base month and every other month of 2010 was expressed as a factor of the base month. Companies trading on the JSE in a foreign currency were included in the sample by converting the monetary values to Rand (South African currency), using the appropriate exchange rate on the financial year-end date for each company. Table 3 and Table 4 show the descriptive statistics for the remuneration components (inputs) and the remuneration determinants (outputs), respectively.

Table 3: Descriptive Statistics for CEO Remuneration Components

Remuneration Components	Salary (R)	Perquisites and Pension (R)	Annual Bonus Plans (R)	Gains On Shares (R)
Mean (Average)	3,503,827	633,207	3,098,542	3,466,495
Median	2,650,000	356,563	1,663,000	0
Standard Deviation	3,870,023	1,292,309	4,595,824	39,314,269
Minimum	567,820	0	0	0
Maximum	44,100,687	14,734,000	27,879,360	583,020,833

Source: Own calculations based on data from McGregor BFA

Table 4: Descriptive Statistics for Remuneration Determinants

Remuneration Determinants	Return On Equity	Total Assets (Incl. Intangible Assets) (R'000)
Mean (Average)	19.61%	41,863,062
Median	14.07%	3,817,608
Standard Deviation	32.50%	145,473,062
Minimum	0.00%	48,677
Maximum	430.18%	1,336,308,000

Source: Own calculations based on data from McGregor BFA

Model Formulation

This study is based on the DEA model presented by Zhu (2004) for both the input-orientated and output-orientated approaches. These models are based on VRS, which takes account of different CEO remuneration policies across the different companies under review. A set of n observations will be considered on the CEOs. Each observation, CEO_j ($j = 1,...n$), uses m inputs x_{ij} ($i = 1,2,...,m$) to produce s outputs y_{rj} ($r = 1,2,...,s$). The efficiency frontier will be determined by these n observations. The mathematical formulations of the input- and output-orientated approaches are shown in Table 5. CEO_0 represents one of the n CEOs under review and x_{i0} and y_{r0} are the ith input and rth output for CEO_0, respectively.

Table 5: DEA Models

Input-Orientated	Output-Orientated
$min\theta - \varepsilon(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+)$	$max\phi - \varepsilon(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+)$
$Subject\ to$	$Subject\ to$
$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = \theta x_{i0} \quad i = 1, 2, \dots, m;$	$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = x_{i0} \quad i = 1, 2, \dots, m;$
$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{r0} \quad r = 1, 2, \dots, s;$	$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = \phi y_{r0} \quad r = 1, 2, \dots, s;$
$\sum_{j=1}^{n} \lambda_j = 1$	$\sum_{j=1}^{n} \lambda_j = 1$
$\lambda_j \geq 0 \qquad j = 1, 2, \dots n.$	$\lambda_j \geq 0 \qquad j = 1, 2, \dots n.$

Source: Zhu (2004)

The value of θ represents the input-orientated efficiency score and ϕ the output-orientated efficiency score of CEO_0. If $\theta = 1$ or $\phi = 1$, CEO_0 lies on the frontier. If $\theta < 1$ or $\phi > 1$, CEO_0 is inefficient and should either decrease its input levels or increase its output levels. It is possible for the DEA to indicate an individual input reduction or output increase for a specific CEO in order to move it onto the frontier. These input reductions or output increases are called input or output slacks and are represented by s_i^- and s_r^+, respectively. The presence of ε in the input-orientated model allows the minimization over θ to pre-empt the optimization involving the slacks, s_i^- and s_r^+. The model is therefore calculated in a two-stage process. Firstly, maximal reduction of inputs is achieved by optimizing θ. Secondly, movement onto the frontier is achieved by optimising the slack variables. Similarly, the output-orientated model is also calculated in a two-stage process by firstly calculating ϕ and then optimizing the slacks by fixing ϕ. Ray (2004) clarifies slacks with a simple example: Suppose that in a particular application $\phi^* = 1.25$ is obtained. This means that all the outputs should be increased by 25% for the company to become fully efficient. Now suppose that $s_1^{+*} = 10$. This implies that output$_1$ can be further increased by 10 units. Moreover, if any one of the input slacks is strictly positive, the previous expansion of the outputs can be achieved while reducing individual inputs at the same time.

The left-hand sides of the models shown in Table 5 are called the 'Reference Set' and the right-hand side represents the specific CEO under evaluation. The non-zero optimal λ_j represents the benchmarks for the specific CEO under evaluation. The reference set, as shown in Table 5, provides coefficients (λ_j) to form the hypothetical efficient CEO. The reference set shows how inputs can be decreased and outputs increased to make the CEO under evaluation efficient.

RESULTS

This section presents the results obtained from the DEA. The first and second sub-sections fulfill the first purpose of the study and provide an overview per industry of the efficient and inefficient companies as well as the distribution of the companies with efficiency scores within a certain range for the input-orientated and output-orientated approaches, respectively. The third sub-section fulfils the second purpose of the study and presents the results from two of the most useful features of the DEA, namely to indicate the benchmark companies and to suggest potential improvements for inefficient companies.

Table 6: Descriptive Statistics for Efficient and Inefficient CEOs

	Salary (R)	Perquisites and Pension (R)	Annual Bonus Plans (R)	Gains on Shares (R)	ROE	Total Assets (R'000)
Average						
Efficient (n=80)	3,830,728	569,075	2,828,450	901,929	27.63%	58,724,823
Inefficient (n=141)	3,318,351	669,594	3,251,786	4,921,568	15.06%	32,296,106
Minimum						
Efficient	567,820	0	0	0	0.00%	48,677
Inefficient	829,665	0	0	0	0.75%	86,720
Maximum						
Efficient	44,100,687	6,105,861	27,879,360	36,720,160	430.18%	1,336,308,000
Inefficient	24,860,518	14,734,000	25,957,049	583,020,833	99.64%	828,919,309

Source: Own calculations based on data from McGregor BFA

After the DEA has been applied to the sample, a distinction could be made between the efficient and inefficient CEOs. Table 6 presents the descriptive statistics for these two groups within the sample. In total, 80 of the 221 companies included in the sample emerged as the benchmark companies and formed the efficiency frontier against which the inefficient companies were compared. Table 6 points out that the average salary paid to CEOs of efficient companies (from here on referred to as 'efficient CEOs') is higher than the average salary paid to CEOs of inefficient companies ('inefficient CEOs'). It also points out that the amounts of Perquisites and Pension, Annual Bonus Plans and Gains on shares for inefficient CEOs exceed those of the efficient CEOs, while company performance (ROE) and size (Total Assets) are less than that of efficient CEOs. This explains why these CEOs are deemed as inefficient, because their current remuneration levels are not justified by the company's current performance and size.

Input-Orientated Results

The input-orientated efficiency score is expressed as 1.0 (or 100%) for efficient companies and less than 1.0 (or < 100%) for inefficient companies. Each industry was analyzed separately with the DEA and Table 7 shows how the companies in each industry are distributed between the efficient and inefficient groups for the input-orientated approach.

Table 7: Input-Orientated Efficiency Score Distribution

Input-Orientated	Efficient		Inefficient				
Industry	No.	%	No.	%	Total	Minimum Efficiency Score	Average Efficiency Score
Basic Materials, Oil & Gas	14	33%	28	67%	42	0.259	0.709
Consumer Goods	13	65%	7	35%	20	0.628	0.923
Consumer Services	8	24%	25	76%	33	0.389	0.757
Financials	13	27%	35	73%	48	0.134	0.577
Healthcare, Technology, Telecommunications	12	57%	9	43%	21	0.222	0.730
Industrials	20	35%	37	65%	57	0.356	0.763
Total	**80**		**141**		**221**		

Source: Calculations based on data from McGregor BFA and elaborated using the software of Zhu (2004)

Table 7 shows that the Consumer Goods industry has the highest percentage of efficient companies, followed by the Healthcare, Technology and Telecommunications industry, while the Consumer Service industry has the lowest percentage of efficient companies. It further shows that the lowest input-orientated efficiency score of 0.134 falls within the Financials industry and that this industry also has the lowest average input-orientated efficiency score of 0.577. This means that, on average, companies within this industry are only 57.7% efficient and have to reduce their remuneration packages by at least 42.3% in order to be fully efficient (57.7% + 42.3% = 100%).

Output-Orientated Results

The output-orientated efficiency score is also expressed as 1.0 (or 100%) for efficient companies, but more than 1.0 (or > 100%) for inefficient companies. Table 8 shows how the companies in each industry are distributed between the efficient and inefficient groups for the output-orientated approach.

Table 8: Output-Orientated Efficiency Score Distribution

Output-Orientated	Efficient		Inefficient			Maximum	Average
Industry	No.	%	No.	%	Total	Efficiency Score	Efficiency Score
Basic Materials, Oil & Gas	14	33%	28	67%	42	15.494	3.796
Consumer Goods	13	65%	7	35%	20	5.629	1.376
Consumer Services	8	24%	25	76%	33	19.258	2.406
Financials	13	27%	35	73%	48	15.066	2.801
Healthcare, Technology, Telecommunications	12	57%	9	43%	21	6.141	1.793
Industrials	20	35%	37	65%	57	11.736	1.991
Total	**80**		**141**		**221**		

Source: Calculations based on data from McGregor BFA and elaborated using the software of Zhu (2004)

The same number of companies per industry is efficient under the output-orientated approach in Table 8 compared to the input-orientated approach in Table 7. In Table 8, the highest efficiency score indicates the least efficient company. The maximum output-orientated efficiency score of 19.258 exists in the Consumer Services industry, which means that the CEO of that company has to increase current company performance and size by more than 19 times in order to justify his/her current remuneration. It further points out that the Basic Materials and Oil & Gas industries have the highest average output-orientated efficiency score of 3.796, indicating that, on average, these CEOs have to increase company performance and size by almost four times in order to be efficient.

Benchmarks and Improvements

The benchmarking power of the DEA lies in its ability to identify efficient companies and to suggest target remuneration levels, company performance and size values for the inefficient companies by comparing them to the efficiency frontier created by the efficient companies. After applying the DEA, several companies within each industry emerged as the benchmark companies for that particular industry. The benchmark companies are those companies that obtained an efficiency score of 1.0 under the input-orientated or output-orientated approach.

The DEA compares each of the inefficient companies to the benchmark companies within its industry to establish specific targets for both the inputs and outputs that the inefficient company or CEO has to obtain in order to be efficient. Under the input-orientated approach, the input reductions required to reach the input targets are also an indication of how much overpaid the CEO is. Alternatively, under the output-orientated approach, the output increases required to reach the output targets are an indication of how much the CEO is currently underperforming. Table 9 summarizes the potential improvements for inefficient CEOs by presenting them as input reductions and output increases required per industry:

Table 9: Potential Improvements for Inefficient CEOs

	Reduction required				Increase required	
	Salary	Perquisites and Pension	Annual Bonus Plans	Gains on Shares	ROE	Total Assets
Basic Materials, Oil & Gas						
Average	-43.6%	-45.3%	-59.1%	-25.0%	35.2%	419.4%
Min	-0.3%	0.0%	0.0%	0.0%	1.8%	1.9%
Max	-74.1%	-86.8%	-92.4%	-100.0%	135.4%	1449.4%
Consumer Goods						
Average	-21.9%	-29.1%	-21.6%	-24.3%	7.9%	146.2%
Min	-2.4%	-8.0%	0.0%	0.0%	1.1%	35.3%
Max	-37.2%	-39.3%	-37.2%	-88.1%	16.1%	462.9%
Consumer Services						
Average	-34.1%	-49.5%	-59.7%	-28.0%	17.9%	233.3%
Min	-1.9%	-1.9%	0.0%	0.0%	1.4%	7.0%
Max	-86.4%	-90.8%	-94.6%	-100.0%	42.2%	1825.8%
Financials						
Average	-58.4%	-57.4%	-67.4%	-14.3%	20.8%	410.6%
Min	-24.1%	0.0%	0.0%	0.0%	1.0%	9.4%
Max	-86.6%	-98.4%	-100.0%	-100.0%	42.6%	2450.8%
Healthcare, Technology, Telecommunications						
Average	-62.9%	-67.3%	-72.7%	-22.2%	24.7%	331.7%
Min	-37.5%	-42.6%	-42.6%	0.0%	10.6%	69.3%
Max	-77.8%	-77.8%	-91.1%	-100.0%	57.2%	837.0%
Industrials						
Average	-36.5%	-47.6%	-36.4%	-8.1%	11.5%	152.7%
Min	-0.7%	0.0%	0.0%	0.0%	0.5%	5.8%
Max	-64.4%	-96.3%	-82.1%	-100.0%	33.3%	1073.6%

Source: Calculations based on data from McGregor BFA and elaborated using the software of Zhu (2004)

The information contained in Table 9 should serve as a guideline to boards of directors when the CEO remuneration package is structured. It shows by how much CEOs are currently overpaid and by how much their remuneration should be reduced in order to be in line with the benchmark companies. The lowest minimum reduction required for salary is 0.3 per cent, which means that all of the inefficient CEOs are overpaid to some extent in terms of their basic salary. Furthermore, it shows that Perquisites and Pension, Annual Bonus plans and Gains on Shares indicate minimum reductions of 0 per cent, which means that the current amounts paid in terms of these remuneration components to some CEOs are acceptable. However, the DEA returned interesting results for the Gains on Shares component of remuneration. Only a few CEOs received payment in the form of Gains on Shares, but unless these were CEOs of efficient companies, the DEA suggested a 100 per cent reduction in Gains on Shares (with the exception of two cases within the Consumer Goods industry), meaning that the target amount of Gains on Shares for all inefficient companies is zero. This finding supports public belief (Financial Mail, 2008) that long-term incentive schemes, such as share options, enable CEOs to earn excessive remuneration despite poor company performance and the DEA suggests that CEOs should not be paid any amount in terms of this component.

In Table 9, the output-orientated approach suggests considerable increases in ROE and Total Assets, which means that most of the inefficient CEOs are earning the same as CEOs in much bigger and better performing companies, while their company's current size and performance do not permit him/her being remunerated at such a high level. The output-orientated information is also valuable to boards of directors in showing what the ROE and Total Assets values should be if they were to continue remunerating their CEO at the current level. Table 9 indicates that ROE has to be increased with as little as 0.5 per cent to a maximum of 135.4 per cent and Total Assets by a minimum of 1.9 per cent to a maximum of 2450.8 per cent. It is questionable how inefficient companies manage to afford such excessive remuneration packages when that money could have been utilized elsewhere to improve the performance or size of the company.

A detailed breakdown per company of the specific reductions required for each remuneration component or increase required in company performance and size is shown in Appendix 1. As a result of space restriction, only the Consumer Goods Industry is shown. The table shows both the input-orientated and output-orientated efficiency scores in descending order together with the input reductions and output increases for the companies in this industry.

CONCLUSION

A summary of the results indicates the following:

- Efficient CEOs earn a higher average salary than inefficient CEOs;
- Inefficient CEOs earn higher amounts of Perquisites and Pension, Annual Bonus Plans and Gains on Shares than efficient CEOs, while their company performance (ROE) and size (Total Assets) are less than that of efficient CEOs;
- In total, CEOs from 80 of the 221 companies included in the sample emerged as the benchmark CEOs and formed the efficiency frontier against which inefficient CEOs were compared;
- On average, the Financials industry CEOs are only 57.7 per cent effective and their remuneration packages have to be reduced by at least 42.3 per cent;
- CEOs of the Basic Materials and Oil & Gas industries have to increase company performance and size by almost four times in order to justify their current remuneration;
- The lowest minimum reduction suggested by the DEA for Salary is 0.3 per cent, which means that all of the inefficient CEOs are overpaid to some extent in terms of their basic salary;
- The DEA suggests minimum reductions of 0 per cent for Perquisites and Pension, Annual Bonus plans and Gains on Shares, which means that the current amounts paid in terms of these remuneration components to some inefficient CEOs are acceptable;
- The DEA suggests a 100 per cent reduction in Gains on Shares earned by inefficient CEOs (with the exception of two cases within the Consumer Goods industry), meaning that the target amount of Gains on Shares for all inefficient companies is zero;
- The DEA suggests that ROE has to be increased with as little as 0.5 per cent to a maximum of 135.4 per cent and Total Assets by a minimum of 1.9 per cent to a maximum of 2450.8 per cent in order to justify the current remuneration of inefficient CEOs.

The conclusions that can be drawn from these results are that some CEOs are remunerated at an acceptable (best practice) level because they efficiently turn their remuneration into a number of company determinants, while other CEOs are inefficient because their current remuneration levels are not justified by the company's current performance and size. The contribution of this study, despite its potential limitations, is that it is the first to use the DEA to analyze CEO remuneration of companies listed on the JSE and, instead of only using Total CEO Remuneration in the analysis, this study disaggregated total remuneration into Base Pay, Perquisites and Pension, Annual Bonus Plans and Long-term Incentives to provide more accurate benchmark information. Contrary to other South African studies on CEO remuneration, this study combined the determinants and components of CEO remuneration in a single model to establish benchmarks, based on best practices, and then suggested, from an input-orientated view, reductions to the remuneration package structure, and from an output-orientated view, increases to the size and performance, for overpaid, underperforming CEOs.

The first limitation of the study is that a number of companies had to be excluded from the initial sample, the second limitation is that there might still be considerable differences between companies within the same industry that are not reflected in the DEA results. Despite these limitations, this study provides an alternative way to analyze CEO remuneration and the multi-dimensionality of the DEA allows for many different research scenarios. Firstly, future studies can experiment by using different sets of inputs and outputs by including different remuneration or determinant variables with different measures for these variables. Secondly, the effect of time lags on remuneration can be investigated by using time series data in the DEA. Thirdly, the DEA can also be extended to analyze the remuneration of employees other than the CEO and finally, the DEA can be used with other statistical models to perform a more comprehensive analysis of CEO remuneration.

AUTHOR INFORMATION

Marli Theunissen is currently an assistant cost accountant at VKB Agriculture Limited, an agricultural business whose core strategy is to add value to the agricultural producers in South Africa. She obtained both her BCom and BCom Honors in Management Accounting with distinction at the North-West University (South Africa) and studied as an exchange student for one semester at the Vrije University in Amsterdam (The Netherlands). She recently obtained her master's degree from the North-West University which had focused on the application of DEA on CEO remuneration. E-mail: Marlitheunissen@gmail.com

Professor Merwe Oberholzer is currently Professor in the School of Accounting Sciences at the North-West University (South Africa). He has taught extensively in the Chartered Accountancy and Chartered Management Accountancy programs. His academic research output includes more than 40 peer-reviewed articles and conference presentations. His current research focuses on corporate resilience and performance management. E-mail: Merwe.Oberholzer@nwu.ac.za (Corresponding author)

REFERENCES

1. Anderson, T. (1996). A Data Envelopment Analysis (DEA) Homepage. Retrieved from: www.emp.pdx.edu/dea/homedea.html
2. Avkiran, N.K. (1999). An Application Reference For Data Envelopment Analysis In Branch Banking: Helping The Novice Researcher. *International Journal of Bank Marketing*, 17(5) 206-220.
3. Avkiran, N.K. & Rowlands, T. (2008). How To Better Identify The True Managerial Performance: State Of The Art Using DEA. *Omega: The International Journal of Management Science*, 36 317-324.
4. Bowlin, W.F. & Renner, C.J. (2008). Assessing Gender And Top-Management-Team Pay In The S&P Mid-Cap And Small-Cap Companies Using Data Envelopment Analysis. *European Journal of Operational Research*, 185 430-437.
5. BPP Learning Media. (2010). *CIMA Study Text: Strategic Paper E3 Enterprise Strategy*. 2nd Edition. London: BPP Learning Media.
6. Bradley, S. (2011). Chief Executive Officer Compensation And The Effect On Company Performance In A South African Context. Master's thesis: Rhodes University, Grahamstown.
7. Charnes, A., Cooper, W.W. & Rhodes, E. (1978). Measuring The Efficiency Of Decision Making Units. *European Journal of Operational Research*, 2 429-444.
8. Chen, Y., Gregoriou, G.N. & Rouah, F.D. (2008). Efficiency Persistence Of Bank And Thrift CEOs Using Data Envelopment Analysis. *Computers & Operational Research*. Retrieved from: www.elsevier.com/locate/cor
9. Cordeiro, J.J., Mukherjee, P. & Kent, D.D. (2006). Non-Parametric Assessment Of CEO Compensation Practices. *Management Research News*, 29(5) 242-251.
10. Crotty, A. (2012). Godsell Calls For Inquiry Into Excessive Pay. *Business Report:* 1-2, 21 May. Retrieved from: http://www.iol.co.za/business/business-news/godsell-calls-for-inquiry-into-excessive-pay-1.1300421#.T-W5VuhDya8
11. Devers, C.E., Cannella, A.A., Reilly, G.P. & Yoder, M.E. (2007). Executive Compensation: A Multidisciplinary Review Of Recent Developments. *Journal of Management*, 33(6) 1016-1072.
12. Dommisse, J. (2011). Is The Remuneration Of The Executives Of The 120 Top Companies Of The Johannesburg Stock Exchange (JSE) In Relation With Their Turnover, Income Or Profit Before Interest And Tax Fair?, Master's mini-dissertation: University of Stellenbosch.
13. EL-Mahgary, S. & Lahdelma, R. (1995). Data Envelopment Analysis: Visualizing The Results. *European Journal of Operational Research*, 85 700-710.
14. Ensor, L. (2010). Gordhan Warns Of Dangers In High CEO Pay. *Business Day:* 1-2, 12 May. Retrieved from: http://www.businessday.co.za/articles/Content.aspx?id=108643
15. Farrell, M.J. (1957). The Measurement Of Productive Efficiency. *Journal of the Royal Statistical Society*, 120(3) 253-290.
16. Feroz, E.H., Kim, S. & Raab, R.L. (2003). Financial Statement Analysis: A Data Envelopment Analysis Approach. *The Journal of the Operational Research Society*, 54(1) 48-58.

17. Financial Mail. (2008). Executive Pay – Is Intervention Required? *Financial Mail*: 1-5, 2 Aug. Retrieved from: http://www.leader.co.za/printarticle.aspx?s=1&f=1&a=825
18. Finweek.(2012). Investec's Koseff Leads Corporate Gravy Train. *Finweek*: 24-25, Mar. 29th.
19. Frydman, C. & Jenter, D. (2010). CEO Compensation. Working paper 77. Rock Centre for Corporate Governance at Stanford University. Retrieved from: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1582232
20. Hayes, R.M. & Schaefer, S. (2007). *CEO Pay And The Lake Wobegon Effect*. Salt Lake City: University of Utah.
21. Janssen, T. (2009). CEO Remuneration Clarified: What Determines Top Executive Pay In The Netherlands? Master's thesis: Maastricht University.
22. Krugel, L. & Kruger, J. (2006). Remuneration Of Chief Executive Officers: An Overview Of JSE Listed Companies. Solidarity Research Institute.
23. Lippert, R.L. & Moore, W.T. (1994). Compensation Contracts Of Chief Executive Officers: Determinants Of Pay-Performance Sensitivity. *The Journal of Financial Research*, 17(3) 321-332.
24. McGregor BFA. (2012). Database. Retrieved from: http://mcgregorbfa.co.za
25. Mohan, N. & Ruggiero, J. (2003). Compensation Differences Between Male And Female CEOs For Publicly Traded Firms: A Nonparametric Analysis. *The Journal of the Operational Research Society*, 54(12) 1242-1248.
26. Murphy, K.J. (1999). Executive Compensation. California. (Unpublished.).
27. Oberholzer, M. & Theunissen, M. (2012). M. Benchmarking Of Johannesburg Stock Exchange CEO Compensation. *International Business & Economics Research Journal.* The Clute Institute. Retrieved from: http://journals.cluteonline.com/index.php/IBER/article/view/7189/7262
28. Paradi, J.C., Rouatt, S. & Zhu, H. (2010). Two-Stage Evaluation Of Bank Branch Efficiency Using Data Envelopment Analysis. *Omega*. Retrieved from: www.elsevier.com/locate/omega
29. PwC (PricewaterhouseCoopers). (2010). Executive Remuneration In Need Of A Major Makeover. *PwC:* 1-3, 23 Jul. Retrieved from: http://www.pwc.com/za/en/press-room/
30. RAY, S.C. (2004). *Data Envelopment Analysis: Theory And Techniques For Economics And Operations Research*. Cambridge: Cambridge University Press.
31. Sapa. (2011). COSATU slams CEO pay hikes. *Fin24*: 1, 11 Jul. Retrieved from: http://www.fin24.com/Economy/Cosatu-slams-CEO-pay-hikes-20110711
32. Thanassoulis, E. (1993). A Comparison Of Regression Analysis And Data Envelopment Analysis As Alternative Methods For Performance Assessments. *The Journal of the Operational Research Society*, 44(11) 1129-1144.
33. Theunissen, P. (2010). *Is Executive Remuneration Out Of Control?* Bethlehem: Hooglandpers.
34. Yanadori, Y., Sturman, M.C., Milkovich, G.T. & Marler, J.H. (2002). Organizational Pay Mix: The Implications Of Various Theoretical Perspectives For The Conceptualization And Measurement Of Individual Pay Components. Working paper 43. Centre for Advanced Human Resource Studies. Retrieved from: http:// digitalcommons.ilr.cornell.edu/cahrswp/43/
35. Zhu, J. (2004). *Quantitative Models For Performance Evaluation And Benchmarking: Data Envelopment Analysis With Spreadsheets And DEA Excel Solver*. Massachusetts: Kluwer Academic Publishers.

Appendix 1: Consumer Goods Results

Consumer Goods	Input-Orientated Efficiency	Reduction required				Output-Orientated Efficiency	Increase required	
		Salary	Perquisites and Pension	Annual Bonus Plans	Gains on Shares		ROE	Total Assets
Amalgamated Appliance Holdings	1.000					1.000		
Astral Foods	1.000					1.000		
British American Tobacco Plc	1.000					1.000		
Compagnie Financiere Richemont Sa	1.000					1.000		
Country Bird Holdings	1.000					1.000		
Crookes Brothers	1.000					1.000		
Distell Group	1.000					1.000		
Illovo Sugar	1.000					1.000		
Metair Investments	1.000					1.000		
Sabmiller Plc	1.000					1.000		
Steinhoff International Holdings	1.000					1.000		
Tiger Brands	1.000					1.000		
Tongaat Hulett	1.000					1.000		
Nu-World Holdings	0.976	-2.4%	-39.3%	0%	0%	1.044	1.1%	178.3%
Oceana Group	0.920	-8.0%	-8.0%	-8.0%	0%	1.121	1.3%	110.5%
AFGRI	0.802	-19.8%	-32.7%	-19.8%	0%	1.353	6.7%	35.3%
Pioneer Food Group	0.795	-20.5%	-20.5%	-20.5%	-82.3%	1.660	8.5%	66.0%
Rainbow Chicken	0.673	-32.7%	-32.7%	-32.7%	0%	1.701	9.4%	70.1%
AVI	0.670	-33.0%	-33.0%	-33.0%	-88.1%	2.002	16.1%	100.2%
Sovereign Food Investments	0.628	-37.2%	-37.2%	-37.2%	0%	5.629	12.3%	462.9%