ARE EFFICIENT CEOs HIGHER REMUNERATED? A DATA ENVELOPMENT ANALYSIS OF SELECTED JOHANNESBURG SECURITY EXCHANGE COMPANIES

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Abstract

The originality of the study is that performances of CEOs are estimated by determining how efficiently they convert their own remuneration and other key company input resources into a key performance output. Accounting-based data, with the Du Pont analysis as conceptual framework, were applied as the other company input and output determinants. The main purpose was to determine whether there is a difference in remuneration of CEOs who are efficient and inefficient, as estimated by data envelopment analysis. A sample of 167 Johannesburg Stock Exchange-listed companies, divided into large, medium and small, from the industrial and resource sectors is empirically investigated. According to the Student t test, the study found that there is no statistically significant difference between the remuneration of efficient and inefficient CEOs of large and small companies, but for medium-sized companies, the inefficient CEOs are statistically significantly higher remunerated. A possible reason for this contradiction is, inter alia, that market-based performance determinants were not taken into account, which could lead to a different conclusion. The practical implication is that an accounting-based model is developed for company boards, which should consider using accounting-based data more frequently to benchmark their CEOs' remuneration, since not only are these data readily available to make comparisons with peers, but it can be influenced more easily by a CEO as in the case of market-based determinants.

Keywords: CEO Remuneration, Efficiency, Performance, Du Pont Analysis, Accounting-Based, Data Envelopment Analysis

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1. Introduction

The debate concerning CEO remuneration is and old issue and the majority of research in this field questions the relationship between firm performance and CEO remuneration (Geiger and Cashen, 2007). Stanwick and Stanwick (2001) mentioned more than a decade ago that although the topic of CEO remuneration is well explored in academic research, there is still a great deal to be learned. Approximately 25 years ago, Jensen and Murphy (1990) identified the core of the problem when researching the performance-remuneration issue, namely that the results are inconsistent. Today, there is still a great deal to be learned, because researchers still provide a stream of mixed results. There are many recent studies' results that support the hypothesis of a relationship between CEO remuneration and performance (Nulla, 2013; Faleye et al., 2013; O'Connell and O'Sullivan, 2013; Scholtz and Smit, 2012; Sigler, 2011; Lee et al., 2007; Zhou, 2000). On the other hand, many studies could not find a relationship (Bradley, 2011; Theunissen, 2010; Heaney et al., 2010; Krugel and Kruger, 2006; Grinstein and Hribar, 2004; Gunasekaragea and Wilkinson, 2002).

It is clear from the literature that company performance is not the only factor that influences CEO remuneration. Many other factors should also be borne in mind, namely company size, risk, leverage, ownership, age of CEO, tenure, talent, including risk forecasting skills, labor market state and board size (Srivastava, 2013; Hearn, 2013; Sigler, 2011; Fulmer, 2009; Gabaix and Landier, 2008; Nwaeze et al., 2006; Gunasekaragea and Wilkenson, 2002). However, performance and size seem to be the most important drivers of CEO remuneration (Nulla, 2012; Oberholzer, 2014; Cordeiro et al., 2006; Zhou, 2000) and hereof many authors agree that company size is the single most significant driver and the only factor that has a constant and a positive correlation with CEO

remuneration (Dan et al., 2013; Sigler, 2011; Vermeulen, 2008; Devers et al., 2007; Geiger and Cashen, 2007). Therefore, when analyzing the relationship between CEO remuneration and company performance, steps must be applied to control the effect of size (Chen et al., 2009). For example, researchers have conducted relationship studies with market-based determinants (Krugel and Kruger, 2006; Heaney et al., 2010), accounting-based determinants (Chhaochharia & Grinstein, 2009), and other factors, such as number of employees (Sigler, 2011), as possible proxies for company size when studying CEO remuneration.

In an effort to link CEO remuneration with company performance, the majority of studies performed relationship analyses and asked the question whether there is a correlation between CEO remuneration and company performance indicators. Researchers have chosen performance determinants that are market based, such as return to shares, market value, market value added, Tobin's q and market-to-book value (Nulla, 2013; Scholtz and Smit, 2012; Griffith et al., 2011; Bradley, 2011; Heaney et al., 2010; Fulmer, 2009; Lee et al., 2007; Gunasekaragea and Wilkinson, 2002; Zhou, 2000); accounting-based determinants, from the statement of comprehensive income, profit (Nulla, 2013; Theunissen, 2010; Krugel and Kruger, 2006; Grinstein and Hribar, 2003), total sales (revenue) (Scholtz and Smit, 2012; Griffith et al., 2011; Theunissen, 2010; Grinstein and Hribar, 2004; Stanwick and Stanwick, 2001), and from the statement of financial position, equity (Nulla, 2013) and total assets (Scholtz and Smit, 2012); accounting-based ratio determinants used are return on equity, return on assets and earnings per share (Nulla, 2013; Oberholzer and Theunissen, 2012; Bradley, 2011; Sigler, 2011; Heaney et al., 2010; Fulmer, 2009; Grinstein and Hribar, 2004; Stanwick and Stanwick, 2001; Zhou, 2000); and other factors, such as customer satisfaction (O'Connel and O'Sullivan, 2013). From this summary of previous studies, it is clear that there are many performance determinants to choose from and that most researchers prefer to apply multiple determinants. Therefore, it is a difficult task to select appropriate performance measures, which makes a case for the selection to be based on a predetermined framework.

This study differs from the above-mentioned studies and investigates an issue that has not received much attention before. This is to define performance as the efficiency of CEOs to convert their own remuneration, as well as other key company resources into key outputs. The argument of the study is that CEOs can be seen as company resources – and resources should be utilized to create wealth. It will be a one-dimensional view if CEO remuneration is considered as the only resource; therefore, what is needed is a model to estimate the efficiency of how multiple company resources can be converted into key outputs. For this matter, the study will apply data envelopment analysis (DEA) because it has the ability to aggregate the relative efficiency into a single measure where multiple inputs and multiple outputs are used (Avkiran, 2011; Coelli et al., 2005).

The study attempts to classify CEOs as efficient or inefficient and the research question is whether efficient CEOs are higher remunerated than inefficient CEOs. The main purpose of the study is to determine whether there is a statistically significant difference in remuneration between those groups. The secondary purpose is to perform a relationship analysis regarding to the extent that CEOs' remuneration changes when there is a change in performance. A related study has been done by Faleye et al. (2013), who investigated the relationship between productivity and CEO remuneration. Another study, closely related to this study, has been conducted by Chen et al. (2009), who investigated the relationship between banks' CEO efficiency, by using DEA and CEO remuneration. Other authors who used DEA in studying CEO remuneration are Cordeiro et al. (2006), Oberholzer and Theunissen (2012), and Theunissen (2012), who investigated DEA models to benchmark CEO remuneration as an alternative for regression analysis.

To fulfill the purpose, a sample of 167 Johannesburg Stock Exchange (JSE)-listed companies from the industrial and resource sectors is empirically investigated. A DEA model is developed to estimate the efficiency that CEOs convert their own remuneration and other inputs into performance outputs. The DEA results are used to classify CEOs as either efficient or inefficient. Statistical methods applied are firstly descriptive statistics, secondly the Student t test, to investigate the mean differences between the remuneration of efficient and inefficient CEOs, and thirdly, the Spearman rank-order correlation, to investigate the relationship between the efficiency (performance) of CEOs and their remuneration. To address the effect of size influences on CEO remuneration, the sample companies are divided into three groups according to their size, measured by the market value of assets. Assuming the companies in a group are more or less of a similar size, the problem is addressed that company size may have threatened the validity of the study (Bradley, 2011). With both the Student t test and the Spearman rank-order correlation test, the mean company size of efficient CEOs is statistically tested to be equal to those of inefficient CEOs' company size, and that there is no relationship between company size and CEO remuneration, respectively.

This study brings new insight to the literature. By estimating the efficiency of CEO remuneration, in conjunction with other multiple company

resources to create wealth, the contribution is that it provides a basis that goes beyond the questions of the relationship between performance and remuneration. The efficiency estimate provides a best practice benchmark to indicate to what extent inefficient CEOs' remuneration (and other key input resources) should be decreased maintaining the current output performance levels. From this study, an accounting-based model is created that can be used by board members to benchmark their CEOs' remuneration against its peers.

The remainder of the study will evolve as follows: The next section provides the background, including the rationale of the study, the rationale of applying DEA and the conceptual scope of the study. This will be followed by a theory section to explain DEA. Thereafter, the method and materials are explained. This will be followed by the findings of the empirical study and then a discussion thereof and the study will be concluded thereafter.

2. Background

Rationale of the study

CEO remuneration recently received a great deal of negative media attention in South Africa and companies are accused of the fact that their CEOs are excessively remunerated (Lamprecht, 2014; Finweek, 2012; Joubert, 2011; Ensor, 2010). This media attention has led to a number of studies investigating CEO remuneration of JSE-listed companies (Nthoesane and Kruger, 2014; Bradley, 2011; Theunissen and Oberholzer, 2013; Scholtz and Smit, 2012; Oberholzer and Theunissen, 2012; Dommisse, 2011; Theunissen, 2010; Krugel and Kruger, 2006). The reason for the media attention is summarized by Theunissen (2012) as firstly that CEOs gain huge amounts of remuneration when they exercise their share options, which is mainly a function of the prevailing share price that is due to market factors and not so much their own contribution. Secondly, there is a presumption that the discrepancy between remuneration and performance has led to these pay hikes. Thirdly, the 'Lake Woebegone Effect', which is a perpetual upward spiraling effect where companies are paying ever-increasing compensation to their CEOs, because most boards want their CEOs to be in the top half of the CEO peer group to convince shareholders that they are above average. This study is an effort to investigate the performance-remuneration issue from a different angle, i.e. the efficiency of CEOs, to be able to conclude whether there is fairness in CEO remuneration.

Rationale of applying DEA

This study applies DEA as a measurement of company performance, which is a non-parametric efficiency measurement technique, using linear programming to estimate a comparative ratio of weighted outputs to weighted inputs for each company. The efficiency estimate is relative to the other companies in the sample and can be expressed in terms of technical, allocative, scale and cost efficiencies, although this study only focuses on technical efficiency, an indication of how well inputs are converted into outputs (Coelli et al., 2005). The main reason for applying DEA is its ability to accommodate multiple inputs and multiple outputs (Avkiran, 2011; Coelli et al., 2005). As seen from the introduction, measuring CEO performance requires that multiple company determinants should be considered. Therefore, DEA will be an effective approach to estimate which CEOs are efficient or inefficient.

Although many previous studies have measured CEO performance as indicated by market performance, this study excludes market performance, since the argument is that CEOs have little or no influence on the market. To a certain extent, a CEO can influence the share price through good governance, but there are also numerous uncontrollable market factors that can influence the share price (Financial Mail, 2008). Therefore, this study will focus on accounting data to select appropriate input and output variables for its DEA model. An advantage of using accounting-based data is that it is readily available. Non-accounting data, such as number of employees, number of transactions, number of retail outlets and/or branches (Cronje, 2002), which are frequently used in DEA models, are also not included because they are not readily available.

Applying a DEA model with multiple input and output accounting-based data provides a superior measurement, since the problem with accounting line items in financial statements is that they are meaningless on their own and must be interpreted against the backdrop of the accounting policy (Correia et al., 2011). Accounting-based ratio analysis is a technique to further analyze financial statements that express a relationship between two accounting line items; however, the problem is the selection of an appropriate ratio, since the literature cannot agree on the relative importance of the different ratios and it is only appropriate if companies focus on a single input to convert into a single output (Chen, 2002).

Nevertheless, instead of focusing on individual accounting line items, researchers have developed multiple input multiple output accounting-based DEA models where the relative performance of firms is aggregated into a single estimate. The input variables consist of accounting line items, such as assets, equity and expenses, as well as output variables such as revenue and profit (Oberholzer; 2013; Ho and Oh, 2010; Guzmán and Arcas, 2008; Lo and Lu; 2006; Luo, 2003; Seinford

and Zhu, 1999). Other researchers have developed DEA models and use financial ratios as input and output variables in their models (Avkiran, 2011; Ablanedo-Rosas et al., 2010; Edirisinghe and Zhang, 2007; Halkos and Salamouris, 2004). These models serve as a basis for this study to create its own DEA model.

Conceptual scope

For any study to be sensible, it should have a conceptual scope as a basis to measure the results against. For this study, the Du Pont analysis is chosen for this role. This analysis consists of three ratios to measure profit performance, which are calculated by using several accounting-based line items. The Du Pont analysis indicates how the net profit margin and asset turnover affect return on assets, and how return on assets and leverage affect return on equity (ROE) (Figure 1). The strength of the Du Pont analysis model is its ability to aggregate the performance of firms into three broad categories, namely income, investments and capital structure (Correia et al., 2011). Therefore, the Du Pont analysis is an internal profit performance measurement, because it is only based on accounting line items without any market-based influences.

Figure 1. Du Pont Analysis

ROE = (net profit/sales) x (sales/assets) x (assets/equity)

Profit margin
Return on assets
Return on equity

(Source: Correia et al., 2011).

Starting from the far right side in Figure 1, the efficiencies are measured pertaining to how (1) equity is converted into assets, (2) how assets are converted into sales, and (3) how sales are converted into net profit. It is indicated that assets, sales and profit are alternately the output variables, and equity, assets and sales are alternately the input variables. Therefore, assets and sales are both inputs and outputs and equity is only an input and profit is only an output. The input-output issue becomes clear when it is explained within the context of the business cycle, where capital (equity plus liabilities) is needed to acquire assets, and assets are utilized to generate sales revenue, and sales revenue is utilized to realize a profit. To accommodate these four variables in a single model, the logic is to use the first two components in the business cycle sequence, namely equity and assets, as input variables, and the last two, namely sales and profit, as output variables. Note that it will not make sense to use capital, or both its components, equity and liabilities, as input in conjunction with assets, because the sum of equity and liabilities equals assets. A problem that may arise is that when companies expand their operations by increasing their assets, the new assets may be financed by debt, in other words by increasing liabilities. This will lead to the adverse situation that the equity-to-debt ratio becomes distorted with more weight in liabilities, which increases the financial risk of the company. To ensure that CEOs limit this risk, the study recommends that when assets and equity are used as input variables, they should be accompanied by the leverage ratio, liabilities/equity, which implies that low liability and high equity levels reduce finance risk. It also makes sense to include leverage, because Chintrakarn et al. (2014) concluded that powerful CEOs avoid debt and view leverage as negative.

Another phenomenon in practice is that many companies experience net losses from time to time. The problem is that DEA cannot deal with negative data (Kerstens and Van de Woestyne, 2009; Zhu, 2009). To solve this problem, the study recommends that profit is removed as output variable and replaced by total expenditure as an input variable, since the product of sales less expenditure equals profit. The rationale is that profit can be omitted by using expenditure as an input standing opposite to sales, the output variable. Omitting profit as an output performance variable was also done by Frijns et al. (2012), Oberholzer (2012), and Wang et al. (2010).

3. Theory

DEA as an efficiency measurement

A model is needed to estimate the technical efficiency of CEOs to convert inputs into outputs. For this purpose, DEA was selected by comparing the efficiency of how the same multiple inputs and the same multiple outputs are converted by a company, relative to their peers included in the sample (Min et al., 2009; Coelli et al., 2005). DEA effectively estimates the frontier by finding a set of linear segments that envelop the observed data.

DEA can determine efficiencies from an input-orientated (input minimization) or output-orientated (output maximization) point of view (Coelli et al., 2005). Two approaches are available, i.e. constant return to scale (CRS) and variable return to scale (VRS). The CRS implies a proportionate rise in outputs when inputs are increased (Avkiran, 1999). CRS assumes that a company is automatically considered fully scale efficient, implying that the company always achieves economies of scale. Although the technical efficiency based on CRS provides the ultimate optimal value, its assumption is significant, since CRS may only be valid over a limited range and its use should be justified (Anderson, 1996). Alternatively, the less restricted VRS approach can be used, which implies a disproportionate rise or fall in outputs when inputs are increased (Avkiran, 1999). In other words, applying CRS means that the analyst expects that the remuneration-to-size ratio should stay unchanged, implying the largest and the smallest company in a size category have similar remuneration-to-size ratios. An analyst applying VRS assumes that this ratio may change over the spectrum, implying that the ratios for smaller and larger companies in a group may differ.

The less restricted VRS approach is selected for this study so that the size of the companies has as little as possible influence on the efficiency to convert inputs into outputs. Furthermore, an input-orientated approach is followed, which will determine with how much CEO remuneration and other company input resources should decrease to maintain the current level of output. The software provided by Zhu (2009) is used for this study. The technical efficiencies can take on values between zero and one, where zero signals total inefficiency and one total efficiency. [For a comprehensive explanation of the mathematics for an input-orientated VRS approach, see Zhu (2009) and Coelli et al. (2005).]

4. Method and materials

Method

The epistemological approach of this study is more positivistic than interpretive, embracing an empirical study modeling secondary data obtained from the JSE-listed companies to compare whether the difference between efficient and inefficient CEOs' remuneration is statistically significant. Findings made from secondary data provide a medium to high level of control (Mouton, 2011), implying medium to high reliability of the findings if the research process is described in such a way that a repetition thereof will lead to similar findings. The validity of the study is ensured by incorporating only CEO remuneration and other accounting-based variables that can fulfill the purpose of the study.

Data

Data were extracted from the McGregor BFA (2014) database for 2013. From the database, analysts have a choice between published or standardized data. The former was selected for the study because this is the readily available format provided in companies' annual integrated reports, and this study did not attempt to compare data from different companies, which may require some sort of standardization. In a few cases, where monetary values are not in terms of rand (ZAR), the average exchange rate of 2013 was applied to convert those values. Furthermore, one company has changed its financial year-end and the values for nine months in its statement of comprehensive income are proportionally converted to 12 months.

The companies listed on the main board of the JSE are grouped into three main sectors, i.e. resource, industrial and financial (Business Day, 2014). For this study, only resource and industrial companies are included in the sample, since many financial companies have low levels of assets, making them difficult to compare to other sectors. It was also practice to omit the financial companies in similar studies, for example Nulla (2013), Frijns et al. (2012) and Lee et al. (2007).

A total of 218 companies were detected in the database, of which only 167 are operational and/or provided all the required data. It has already been explained that company size may have a significant influence on CEO remuneration. To eliminate the size effect, the companies were divided into three equal groups; 56 large, 56 medium and 55 small companies. This three-level classification was also applied by Nulla (2012), who investigated 120 TSX/S&P companies. Previous studies used the following variables as proxies for company size when studying CEO remuneration: Market-based factors, market capitalization (Krugel and Kruger, 2006); accounting-based factors, from the statement of comprehensive income, turnover/revenue (Chhaochharia and Grinstein, 2009; Fulmer, 2009; Nourayi and Daroca, 2008; Geiger and Cashen, 2007; Stanwick and Stanwick, 2001; Zhou, 2000) and total expenses (Chen et al., 2009), and from the statement of financial position, total assets (Griffith et al., 2011; Chourou et al., 2008; Grinstein and Hribar, 2004; Gunasekaragea and Wilkenson, 2002; Zhou, 2000) and total equity (Theunissen, 2010); and another factor, number of employees (Sigler, 2011; Nourayi and Daroca, 2008). Following Heaney et al. (2010), the market value of assets is used as a proxy for company size, which is represented by the book value of liabilities plus the market value of equity. The following data from the statement of financial position (SFP), statement of

comprehensive income (SCI) and sundry items are extracted from the McGregor BFA database: The average share price for the year [Sundry Items: 149] multiplied by the ordinary shares in issue at year-end [Sundry Items: 101] plus the sum of preference shares [SFP: 008], outside shareholders interest [SFP: 012] and total liabilities [SFP: 022].

Design of DEA model

Two components of CEO remuneration are included as input variables; firstly, guaranteed total costs to company, which include the base pay as measured by 'salary' plus prerequisites and pension as measured by the total of 'retirement and/or medical' contributions, 'allowances and benefits', 'motor and travel' allowances and 'fee/levy payment'; and secondly, annual bonus plans as measured by total of 'bonus paid in current year', 'performance bonus', 'other benefits' and "once-off payments'. To simplify – CEO remuneration is split into these two categories and will be further indicated as "Salary" and "Bonus" and the sum thereof as "Total pay". The database also provides long-term incentives as measured by 'gains on shares'. Since these gains are only disclosed in the year that rights are exercised, it is extremely difficult to value them, especially when only one year's data are under consideration. The exclusion of long-term incentives was also practiced in studies by Nulla (2013), Nulla (2012), Scholtz and Smit (2012), Bradley (2011), and Theunissen (2010). Therefore, this study only investigates the short-term remuneration of CEOs.

The conceptual framework of the study is helpful to identify the remaining input and output variables of the DEA model. The following input variables are selected: total assets, including intangible assets [SFP: 051], total equity [SFP: 013] and leverage that equals total liabilities [SFP: 022] divided by total equity. Dealing with revenue and total expenditure, two approaches can be followed; firstly, where revenue consists of turnover (sales) plus other income, which is investment income and interest received, and total expenditure consists of cost of sales, general administration and selling expenses, interest and financial charges. The alternative, applied in this study, is to use turnover [SCI: 060] as output variable, and total expenditure is the turnover less profit before tax [SCI: 099], which implies that other income is used to reduce total expenditure. The following is a summary of the DEA model:

Input: x1 = CEO salary
X2 = CEO bonus
X3 = Total assets
X4 = Total equity
X5 = Total expenditure
X6 = Leverage
Output: y1 = Turnover

This DEA model differs from those of related DEA studies, for example Chen et al. (2009), who included bank-specific variables such as interest income and expenditure, and non-interest income and expenditure. The models used by Oberholzer and Theunissen (2012), Theunissen (2012), and Cordeiro et al. (2006) were not based on the conceptual framework of the Du Pont analysis and they also did not include other variables in conjunction with CEO remuneration components as input variables.

Statistical analysis

Descriptive statistics

Firstly, descriptive statistics are used to analyze the independent (x) and the dependent (y) variables included in the DEA model. Secondly, descriptive statistics are used to analyze the total short-term CEO pay, which consists of the salary and bonus of efficient and inefficient CEOs. Furthermore, the market value that is used as a proxy for company size will also be analyzed.

Analysis of means

To test the difference between the means of efficient and inefficient CEOs' remuneration, the Student t test statistics are used, assuming independent samples and unknown population standard deviations. Microsoft Excel was used and therefore the F test was first performed to determine whether a t test, assuming equal variances, or a t test, assuming unequal variances, should be run. The null hypothesis states that there is no difference between the means of the two samples; at a level of 5% of significance it implies that $p < 0.05$ assumes unequal variances and $p > 0.05$ assumes equal variances. Thereafter, a one-sided upper-tail hypothesis t test, at the 5% significance level, is performed for the difference between the remuneration means of efficient and inefficient CEOs. The one-sided upper-tail test is required to answer the research question of whether the mean total CEO pay, broken up into salary and bonus, of efficient CEOs is greater than the mean CEO remuneration of inefficient CEOs, ($\mu e - \mu i > 0$). Let e refer to the population of efficient CEOs and i to the population of inefficient CEOs. Then (Wegner, 2007),

$H0: \mu e - \mu i = 0$
$H1: \mu e - \mu i > 0$

The study further hypothesized that there is no difference between the mean market size of large, medium and small companies, respectively, of efficient and inefficient CEOs. This is to determine whether the size classification is valid and that size

effect does not distort the CEO remuneration. Therefore, a two-sided hypothesis test at the 5% level of significance is required, because the market values of the two groups are tested at a specified value ($\mu e - \mu i = 0$). Then (Wegner, 2007),

H0: $\mu e - \mu i = 0$
H1: $\mu e - \mu i \neq 0$

Analysis of relationships

The study also investigated whether there is a monotone relationship between total CEO pay, broken up into salary and bonus, and firstly company size and secondly technical efficiency. The Spearman rank-order correlation coefficient is calculated when the data seem not to be normally distributed; for example, technical efficiency, where all the efficient companies obtain a score of one, while the inefficient companies' scores range between zero and less than one. Since the expectation is that a number of companies will obtain a score of one, it is important to use an average ranking for companies with the same score, e.g. if five companies obtain a score of one, the average ranking for each of them is three and the next company is ranked as number six. The two-sided hypothesis test, at a 5% level of significance, is done to prove that there is no rank-order correlation between CEO remuneration and company size and technical efficiency, ($p = 0$). Then (Wegner, 2007),

H0: $p = 0$
H1: $p \neq 0$.

5. Results

Descriptive statistics for DEA and DEA results

The market value of companies' assets is used as a proxy for size to divide the sample companies into the categories of large, medium and small. Regarding large companies, Table 1 illustrates that the mean of the market value and all the other x and y variables, in monetary terms, are materially higher than the median, implying that there are few companies with appreciably higher variable values than the rest of the companies; the frequency distribution is positively skewed. The same phenomenon can be seen for the medium companies, but the mean and median differences are less extreme than those of the large companies. The variables of small companies are much more normally distributed, with small differences between the mean and median. The minimum and maximum values show that there exists a wide range in each of the three groups.

Table 1. Descriptive statistics of company size and DEA x variables and y variable (Rand (R) million)

	Size	x variables						y variable
Large (n=56)	market value (R)	Assets (R)	Equity (R)	Expen-diture (R)	Leverage	Salary (R)	Bonus (R)	Turnover (R)
Mean	368380	96731	46465	80213	1.33	10.579	5.841	86711
Median	46603	30569	14233	23444	1.08	7.038	4.087	26182
Minimum	16172	3692	1377	2610	0.17	1.560	0.000	1265
Maximum	5338984	1295093	602148	2003996	4.39	101.780	40.676	1945114
Medium (n=56)								
Mean	6285	5108	2610	5738	1.06	3.958	2.850	6154
Median	4710	3597	1679	4611	0.84	3.769	2.034	5189
Minimum	1743	688	461	447	0.15	1.128	0.000	505
Maximum	16159	23134	14998	26529	3.06	14.435	14.406	27401
Small (n=55)								
Mean	761	723	387	969	0.98	2.819	0.982	993
Median	717	644	326	687	0.94	2.597	0.365	798
Minimum	72	61	42	23	0.15	0.798	0.000	10
Maximum	1698	2244	1359	4472	4.00	4.503	9.000	4464

Software, purposefully developed by Zhu (2009), was used to calculate the input-orientated technical efficiency (TE) estimates to determine how efficiently each company is relative to the other companies in its group. Table 2 exhibits the results of the DEA.

Table 2. Technical efficiency according to the VRS approach

	VRS technical efficiency (TE)		
	Large	Medium	Small
Mean	0.922	0.951	0.953
Median	0.999	0.997	1.000
Minimum	0.589	0.611	0.565
Maximum	1.000	1.000	1.000
	n	n	n
Efficient	28	28	28
Inefficient	28	28	27
Total	56	56	55

The mean technical efficiencies of large, medium and small companies in Table 2 of 0.922, 0.951 and 0.953, respectively, imply that the inputs should on average be decreased by 7.8, 4.9 and 4.7% for this group of companies, respectively, to operate on the VRS efficiency frontier. The data in Table 2 were also helpful to identify efficient and inefficient companies; half of the companies in each group are fully efficient, with a technical efficiency score of 1, while the remaining half's scores are less than 1, classified as inefficient.

Hypothesis test for relationship

Testing the null hypothesis regarding to the relationship between CEO remuneration and technical efficiency (TE), the Spearman rank-order correlation coefficient (R) is indicated in Table 3. Note that the relationship between technical efficiency and remuneration is negatively correlated in all cases. H0 is rejected for medium companies' total pay in favor of H1, since there is strong sample evidence ($p < 0.05$), implying that there is a relationship between total pay and technical efficiency. It can therefore be concluded that a strong negative relationship exists between the technical efficiency and the total pay of medium-sized companies' CEOs. There is only weak sample evidence ($0.05 < p > 0.1$) to reject H0 in favor of H1 regarding the bonus of medium-sized companies' CEOs, implying that H0 is probably true – that there is no relationship between the bonus and technical efficiency.

Testing the null hypothesis regarding CEO remuneration and company size, H0 is rejected for large and medium-sized companies' total pay and salaries and medium-sized and small companies' bonuses; there is overwhelmingly strong sample evidence ($p < 0.01$) to support H1. In other words, there is a positive relationship between CEO remuneration and company size.

Table 3. Spearman rank-order correlation coefficient (R)

	Large		Medium		Small	
Remuneration	Size	TE	Size	TE	Size	TE
Salary						
R	0.51	-0.11	0.35	-0.18	0.063	-0.1
p value	<0.001*	0.407	0.007*	0.174	0.646	0.46
Bonus						
R	0.25	-0.05	0.39	-0.22	0.35	-0.029
p value	0.058***	0.704	0.002*	0.1***	0.008*	0.834
Total pay						
R	0.43	-0.13	0.44	-0.29	0.21	-0.11
p value	<0.001*	0.358	<0.001*	0.03**	0.125	0.406

** Significant at 1% (two-sided).** Significant at 5% (two-sided).*** Significant at 10% (two-sided).*

Descriptive statistics of efficient and inefficient CEOs and hypothesis test for means

Table 4 exhibits the descriptive statistics regarding the CEO remuneration and company size of the efficient and inefficient CEOs. In all instances, in monetary values, the means are higher than the medians, implying that there are few companies with appreciably higher variable values than the rest of the companies; the frequency distribution is positively skewed. For large companies, the mean salary and total pay of efficient CEOs are the highest, relative to inefficient CEOs, while the bonuses of inefficient CEOs are the highest. However, the median values for the three components, i.e. salary, bonus and total pay, are higher for the inefficient CEOs. For medium and small companies, the mean and median salary, bonus and total pay of inefficient CEOs are higher than those of efficient CEOs. Also important to

note is that the mean technical efficiency of large, medium and small companies equal one, while the means are 0.843, 0.901 and 0.904 for the three groups, respectively. This implies that, on average, the inputs of the inefficient companies should decrease by 15.7, 9.9 and 9.6%, respectively, for those companies to operate on the VRS efficiency frontier.

Table 4. Descriptive statistics for efficient and inefficient CEOs (Rand (R) million)

Size	Efficient					Inefficient				
	TE	Salary (R)	Bonus (R)	Total pay (R)	Market value (R)	TE	Salary (R)	Bonus (R)	Total pay (R)	Market value (R)
Large (n=28;28)										
Mean	1	11.830	5.692	17.522	424801	0.843	9.328	5.990	15.318	311959
Median	1	6.254	2.371	9.073	37278	0.878	7.413	4.772	11.960	64260
Min	1	1.560	0.000	1.560	16172	0.589	4.192	0.000	6.309	17597
Max	1	101.780	40.676	115.230	5338984	0.998	39.489	30.660	70.149	3130543
Medium (n=28;28)										
Mean	1	3.469	2.202	5.671	5708	0.901	4.448	3.498	7.945	6861
Median	1	3.303	1.442	4.848	4501	0.925	4.051	2.511	7.020	4734
Min	1	1.128	0.000	1.333	1864	0.611	2.400	0.152	3.021	1743
Max	1	6.312	14.406	20.363	16159	0.993	14.435	12.559	26.994	15799
Small (n=28;27)										
Mean	1	2.806	0.844	3.650	798	0.904	2.834	1.125	3.959	722
Median	1	2.469	0.223	2.919	783	0.942	2.804	0.419	3.714	679
Min	1	0.798	0.000	1.084	72	0.565	1.773	0.000	1.894	110
Max	1	4.503	9.000	13.503	1679	0.998	4.503	5.715	9.012	1698

Table 5 is an extension of Table 4 to indicate whether the mean differences between efficient and inefficient CEOs are statistically significant. Calculating the F value was helpful to determine whether equal or unequal variances should be assumed for the t test, where $p < 0.05$ assumes unequal variances and $p > 0.05$ assumes equal variances. Thereafter, a one-sided upper-tail hypothesis t test, at a 5% level of significance, is done for the difference between the remuneration means of efficient CEOs and inefficient CEOs. The negative t values in Table 5 confirm the phenomenon in Table 4 that the mean values for inefficient CEOs are higher than those of efficient ones, except for the salary and total pay of large companies. Regarding medium companies, the $p < 0.05$ for salary and total pay indicates that there is strong sample evidence to reject H0 in favor of H1. Furthermore, there is weak sample evidence for the bonus of medium companies to support H1, which means that H0 is probably true.

Table 5. Hypothesis test for differences in means

Large companies	Salary	Bonus	Total pay	Size
F	7.416	1.991	3.236	2.495
P(F<=f) one-tail	0.000	0.040	0.002	0.010
t Stat	0.631	-0.150	0.443	0.416
P(T<=t) one-tail	0.266	0.441	0.330	
P(T<=t) two-tail				0.680
Medium companies				
F	0.347	0.937	0.686	0.740
P(F<=f) one-tail	0.004	0.434	0.167	0.220
t Stat	-1.968	-1.568	-1.998	-1.018
P(T<=t) one-tail	0.028**	0.061***	0.025**	
P(T<=t) two-tail				0.313
Small companies				
F	2.150	1.792	1.853	1.174
P(F<=f) one-tail	0.027	0.070	0.060	0.343
t Stat	-0.107	-0.667	-0.539	0.575
P(T<=t) one-tail	0.458	0.254	0.296	
P(T<=t) two-tail				0.568

*** Significant at 5% (one-sided).*** Significant at 10% (one-sided).*

Regarding the company size of efficient and inefficient CEOs, the p values are all well above 0.05, implying that there is no sample evidence to support H1.

6. Discussion

The mean technical efficiencies of large, medium and small companies are 0.922, 0.951 and 0.953, respectively (Table 2). When the efficient CEOs (companies) are removed, the mean technical efficiencies of inefficient companies are 0.843, 0.901 and 0.904, respectively (Table 4). This implies that, on average, the inputs, which consist of CEO salary and bonus, total assets, total equity, total expenditure and leverage, should decrease by 15.7, 9.9 and 9.6%, respectively, for the inefficient companies to operate on the VRS efficiency frontier to also become fully efficient.

A statistical test was executed to determine whether there is a monotone relationship between CEO remuneration and technical efficiency. It is hypothesized that the remuneration should be positively correlated with the technical efficiency of CEOs. Against this expectation, the study reveals that the null hypothesis is not rejected, except for the total pay of medium companies, implying that there is no relationship between CEO remuneration and technical efficiency. This means that when the performance of CEOs changes, there is no change in their remuneration. The results are in line with previous studies that could also not find a relationship between CEO remuneration and performance (Bradley, 2011; Theunissen, 2010; Heaney et al., 2010; Krugel and Kruger, 2006; Grinstein and Hribar, 2004; Gunasekaragea and Wilkinson, 2002). For medium companies, the null hypothesis is rejected and the conclusion is made that a statistically significant negative relationship exists between the technical efficiency and the total pay of medium companies' CEOs. These results imply that when these CEOs' efficiencies increase, there is a decrease in their total pay. The results are in contrast with previous studies that found positive relationships between CEO remuneration and performance (Nulla, 2013; Faleye et al., 2013; O'Connell and O'Sullivan, 2013; Scholtz and Smit, 2012; Sigler, 2011).

The statistical test, to determine whether the mean differences between efficient and inefficient CEOs are statistical significant, revealed that the null hypothesis is not rejected for large and small companies, implying that, statistically, there is no significant difference between the remuneration of efficient and inefficient CEOs. For medium companies, the null hypothesis is rejected for salary and total pay, which leads to the conclusion that there is a statistically significant negative difference between the CEO remuneration of efficient and inefficient CEOs. These results imply that for medium-sized companies, the efficient ones are significantly lower remunerated than the efficient ones.

The study also found that there exists a significant positive relationship between the company size for each of the categories, large, medium and small companies, and the CEO remuneration. The results are supported by many other studies that also found that company size is a significant driver for CEO remuneration (Dan et al., 2013; Sigler, 2011; Vermeulen, 2008; Devers et al., 2007; Geiger and Cashen, 2007). The study also found that there are no significant differences between the company size of efficient and inefficient CEOs, which implies that the remuneration of efficient and inefficient CEOs can be compared without the fear that differences in remuneration are driven by company size.

Conclusion

The research question asked whether efficient CEOs are higher remunerated than inefficient CEOs. To answer this question, the main purpose of the study was to determine whether there is a statistically significant difference in the remuneration of efficient and inefficient CEOs. The secondary purpose was to perform a relationship analysis regarding the extent that CEOs' remuneration changes when there is a change in performance. To answer this research question, the study concludes that, for large and small companies, there is no statistically significant proof that the one group is higher remunerated than the other. Regarding medium-sized companies, the answer is clear; efficient CEOs are not higher remunerated than inefficient CEOs. To the contrary, inefficient CEOs are statistically significantly higher remunerated.

There are several possible reasons and/ or limitations of the study, as to why it could not prove that, as expected, efficient CEOs are higher remunerated than inefficient ones. Firstly, this study estimated CEO efficiency using the conceptual framework of the Du Pont analysis, which is accounting-based, to unravel profit performance. Therefore, market-based performance determinants were not taken into account, which could lead to a different conclusion. Secondly, the less restrictive VRS DEA approach was followed. When using the CRS approach, there is much more discriminating power and only CEOs operating on the CRS frontier, who are not only technically efficient but are also scale efficient, will be included in the efficient group. Applying the CRS approach could also lead to a different conclusion. Thirdly, it is possible that CEO remuneration is to some degree related to the performance of previous periods. Therefore, incorporating time lags in the study could also lead to a different conclusion.

The study fills the knowledge gap related to when estimating CEO efficiency that is based on accounting data included in the Du Pont analysis, this efficiency does not drive CEO remuneration. The practical implication of the study is that company boards should pay more attention to benchmark their CEOs' remuneration within the context of their efficiency estimated by accounting-based data. An efficacy accounting-based DEA model is developed for this purpose, because not only are these data readily available to make comparisons with peers, but it can also be influenced more easily by a CEO as in the case of market-based indicators. As found, nearly 50% of the CEOs are to some extent inefficient, and from an input-orientated approach, they are to some extent overpaid. Therefore, the fairness of the 50% inefficient CEOs' remuneration can be questioned, since the efficient CEOs provide a benchmark that indicates on average how much they are overpaid.

The originality is that this is the first effort for non-financial companies to determine DEA efficiency to estimate CEOs' performance and to include CEO remuneration as input variable with other company resources. A logical remuneration-efficiency hypothesis could state that efficient CEOs should be better off. The contribution of this study, within the context of its limitations, is that such a hypothesis should be rejected. Future studies that are recommended are, firstly, to estimate CEO efficiency by using market-based indicators, or a combination of accounting-based and market-based indicators; secondly, to apply the more discriminating CRS approach; thirdly, to incorporate time lags between remuneration and efficiency; and finally, to analyze exactly how much each inefficient CEO is overpaid.

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