NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
POTCHEFSTROOMKAMPUS

SCIENTIFIC CONTRIBUTIONS *(Wetenskaplike Bydraes)*
SERIES H: INAUGURAL ADDRESS: NR. 233

Share prices: A critical perspective of the Greater Fool Theory

Prof Merwe Oberholzer

Inaugural Address held on 26 February 2010

Navrae in verband met *Wetenskaplike Bydraes* moet gerig word aan:
Enquiries regarding *Scientific Contributions (Wetenskaplike Bydraes)* can be directed to:

Die Kampusregistrateur
Noordwes-Universiteit
Potchefstroomkampus
Privaatsak X6001
POTCHEFSTROOM
2520

ISBN 978-1-86822-591-0

Prof Merwe Oberholzer (Ph.D.)
Faculty of Economic and Management Sciences
North-West University. Potchefstroom, 2520, South Africa.

Share prices:
A critical perspective of the Greater Fool Theory

Contents

	Abstract	2
	Keywords	2
	JEL Classification	2
1.	Introduction and statement of the problem	3
2.	Literature review and contribution of the paper	6
3.	Hypothesis	8
4.	Data Envelopment Analysis (DEA)	9
5.	DEA model	13
6.	Data sources and methodology	14
7.	Empirical results	17
8.	Conclusion	22
	References	25

List of Figures

Figure 1: DEA example 12

List of Tables

Table 1: Single-input, two-output example 11

Table 2: Input-orientated technical efficiency, 2004-2008 18

Table 3: Descriptive statistics of variables: Average 2004-2008 19

Table 4: Spearman's rank-order correlation between technical efficiency and profitability and market value ratios 21

Table 5: Ranking of the correlation between technical efficiency and profitability and market value ratios 22

Share prices: A critical perspective of the Greater Fool Theory

Abstract

The purpose of the study is twofold, namely to firstly use Data Envelopment Analysis (DEA) to aggregate the overall performance (technical efficiency) of firms to convert scares resources into outputs that create shareholders' wealth in a single measurement, and secondly, to determine the degree to which this mentioned performance is reflected in a number of profitability and market value ratios. The value of the study is that it is the first study where the results of a DEA model, which aggregates operating, profitability and marketability efficiencies, are compared to profitability and market value ratios. Annual financial statement data were used for 55 manufacturing companies listed on the JSE Limited over a five-year period in a cross-sectional analysis.

The study found that return on equity has the most significant relationship with technical efficiency, followed by return on assets, and to a lesser extent, price/net asset value and price/book value. The market value ratios, i.e. price/earnings, dividend yield and price/cashflow, have a very weak relationship with technical efficiency. Further research is needed and a more advanced DEA analysis should be considered to accommodate measures such as scale, allocative and economic efficiencies

Keywords:

Data Envelopment Analysis, input-orientated, market value ratios, profitability ratios, technical efficiency, variable returns to scale

JEL Classification: C67, G10, M40

Share prices: A critical perspective of the Greater Fool Theory

1 Introduction and statement of the problem

The primary goal of any firm is to create value for its shareholders, i.e. to maximise the fundamental value of a firm's ordinary shares (Brigham & Ehrhardt, 2005:9-10). Fundamental means that the value should be sustainable over the long term (Barker, 2001:5), in other words, it must be supported by anticipated future earnings (Adams, 2002:89). The reason for analysing the fundamental value is to determine a share's intrinsic value – a fancy term for what you believe a share is really worth – relative to the price it is traded in the market (Investopedia, 2009a). This will be helpful to the investor that is always searching for shares that are under valuated by the market and to be picked up as a bargain. The problem with buying these shares is that the investor must wait for the market to come to the same conclusion before he/she can sell it at a profit (Beattie, 2009:2). To complicate it further, is that when the market share price increases, it does not necessarily mean that the investors have grown collectively wealthier, but only that their expectations of future earnings have increased (Barker, 2001:13). Another distortion is that speculation investors buy shares and they are not concerned about how much the market price of a share is represented by its discounted future cashflows and/or how questionable they are with regard to their quality, i.e. the fool theory, but they are more concerned as to whether they can sell it to another investor at a higher price (the [1]greater fool) (Investopedia, 2009a).

Thus, except for the fools and the greater fools, investors search for high quality (high intrinsic value that will realise high future cashflows) shares, that they believe are undervalued by the market, to pick it up as a bargain, wait until the market becomes aware of its real value, which will push it upwards. However, [2]Warren Buffet does not think in these terms. Market volatility will always exist and therefore he is not concerned about it. He is much more concerned about the overall potential of a firm, with the emphasis on long-term ownership in a company, which is extremely capable to generate earnings, rather than share value growth (Investopedia, 2009b). The rationale is that if earnings are good, market value will take care of itself.

Nevertheless, the bottom line of any firm is to create shareholders' wealth. There are many value-based measurements that give substance to this performance of creating shareholders' wealth, for example economic value added (EVA), market value added (MVA), shareholder value added (SVA) and financial ratios, including market value ratios and profitability ratios. MVA, which indicates the growth (or decline) in [3]market values, is the difference between the market share price and its book value (Stewart, 1999:184). The link between MVA and EVA is that MVA is a comparison between a company's market value and the capital provided by the investors over a period of time (Baum *et al.*, 2004:82), and EVA is the present value of future MVAs (Kramer & Peters, 2001:41-42). SVA is the corporate value less the market value of debt (Rappaport, 1986).

A problem is that value-based measurements, such as the above-mentioned, are not readily available and complex to measure (Keys *et al.*, 2001:69) and they do not directly measure the growth and dividend components (Stewart, 1999). Financial ratio analysis, on the other hand, is easy to calculate and also readily available in sources such as financial databases, companies' financial reports and market reports.

In this study, five market value ratios will be investigated. Market value ratios are one of three firm valuation [4]methods (Park & Lee, 2003). The first market value ratio is the price/earnings (PE) ratio, which is an indication of how much investors would be willing to pay per Rand of profit (Fairfield & Harris, 1993:591). The price/book value (PB) ratio is a market value ratio that provides an indication of expectations of future performance by relating the market price of a share to the book value of the share (Dunis & Reilly, 2004:231). The McGregor database also uses a variation of the price/book value ratio, namely the [5]price/net asset value ratio (PNAV). The value of any organisation is the present value of the future free cashflows and therefore the price/cashflow ratio (PCF) is useful, especially where the price of a share is more related to cashflows than net income (Park & Lee, 2003: 335). Finally, there is the dividend yield method, which is an indication of the dividend yield (DY) relative to the share price (Dunis & Reilly, 2004:231). Note that the share price is a common component in all five above-mentioned formulas.

Profitability, which is the stepping-stone in creating shareholders' value and paying dividends, gets substance in ratios, e.g. the ratios included in the Du Pont formula that have the strength that they aggregate the firm's performance in three broad categories, namely income, investments and capital structure (*Correia et al.*, 2007:5-20). This analysis indicates how the net profit margin (PM) and asset turnover (turnover/assets) affect return on assets (ROA), and how ROA and leverage (assets/equity) affect return on equity (ROE) (Brigham & Ehrhardt, 2005:460; Megginson *et al.*, 2008:49). This study will also include the above-mentioned three profitability measures.

A weakness of financial ratios is that the literature cannot agree upon the relative importance of the different ratios, and it is only appropriate if firms focus on a single input or produce a single output (Chen, 2002:201). Another weakness is that they may provide different answers in relation to organisational performance. A firm or a subunit might be highly rated by one of these ratios, while another ratio shows the opposite (Horngren *et al.*, 2009:831). Furthermore, no single financial ratio provides an adequate indication of an organisation's overall performance (Halkos & Dimitrios, 2004:201-224).

What is needed is a measurement tool that can aggregate all inputs (e.g. several scarce resources) and outputs (e.g. the market value growth and dividend components that are not measured by the value-based techniques) in a single performance measurement. The two most widely-used quantitative techniques for measuring relative productivity (or relative efficiency), are Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) (Coelli *et al.*, 2005:6). DEA is used in this study as an efficiency measurement, because it lends itself more easily to the analysis where multiple outputs are used.

The quest for value, that benefits the firm and society, is the result of directing "scarce resources to their most promising uses and most productive users" (Stewart, 1999:1). Thus, the performance of any business is measured in terms of how scarce resources are used as an input to obtain the maximum output. DEA can be helpful in this regard, to aggregate firm performance into a single measurement (Avkiran, 1999:206).

Since financial ratios are readily available, but having the weakness that individually they cannot measure Warren Buffet's idea, i.e. the degree that the overall potential of a firm is reached, the research question of the study is as follows: Which readily available ratios can help the investor not to buy overvalued/questionable shares and become trapped as the greater fool? Thus, the core of the study is that it will investigate what the relative importance of financial ratios (market value and profitability ratios) is to reflect a firms overall performance, measured by the technical efficiency (TE) of using scarce resources to create shareholders' wealth.

Therefore, the purpose of the study is twofold, namely to firstly use DEA to aggregate the performance (efficiency) of firms to convert scarce resources into outputs that create shareholders' wealth in a single measurement, and secondly, to determine the degree to which this mentioned performance (efficiency) is reflected in a number of profitability and market value ratios.

The study will use the DEA efficiency estimates, as a measurement that is superior to financial ratios, as a basis to determine the importance of the different market value ratios and profitability ratios, which are presented by the McGregor database. Section 2 is the literature review and an indication of this paper's contribution, followed by the hypothesis (3) of the study. Sections 4, 5 and 6 explain DEA, the DEA model, data sources and the methodology, respectively. The findings of the empirical investigation are shown in Section 7, and the study is concluded in Section 8.

2. Literature review and contribution of the paper

Many studies used market value ratios as independent variables of performance. For example, Ramcharran and Kim (2008) used price/book value along with price earnings to predict market capitalisation values. While Capaul *et al.* (1993) used only price/book value, Dunis and Reilly (2004) used it along with price/earnings, price/cashflow, dividend yield and market capitalisation to identify significant differences between the performance of "value shares" (shares with a low price/book value ratio) and "growth shares" (shares with a relative high price/book value ratio). Park and Lee (2003) concluded in their empirical study that price/book value is the most accurate measure and outperformed ratios such as price/sales ratio and price/cashflow ratio in forecasting stock prices. On the other hand, Fairfield and Harris (1993) used price deviations from basic valuation models to test the intrinsic value of the dependent variable price/book value and price/earning anomalies. Ramcharran (2003) used country risk data to also estimate several dependent variables, namely equity returns, dividend yield, price/earnings and price/book value.

Some previous studies used DEA efficiency estimates and compared them with profitability ratios and other financial ratios, e.g. Halkos and Dimitrios (2004), Oberholzer and Van der Westhuizen (2004), and Yeh (1996), who found that DEA efficiency estimates are tools to compensate for the weaknesses of financial ratios and that they can be used as an alternative, or complement, to financial ratio analysis. Hassan Al-Tamimi and Lootah (2007:333) also found that financial ratios fail to consider multiple outputs that are provided by multiple inputs, and therefore, DEA efficiency estimates are regarded as superior to financial ratios. Chen (2002) solved the issue to some degree, i.e. the financial ratios versus DEA efficiency estimates debate, by using only financial ratios as outputs in his DEA model. None of these above-mentioned studies focused on market value ratios and they all used a single stage process. Seinford and Zhu (1999) developed a more advanced two-stage process where the first stage measures profitability efficiency and the second stage marketability efficiency. The inputs of the first stage are labour and assets, while revenue and profits are the outputs. The outputs of stage one automatically form the inputs for stage two and the outputs of stage two include market values, returns and earnings per share. The problem with this model is that adjustments should be made to reduce the outputs of the first stage in order to increase the efficiency of the second stage. These adjustments result in a situation where it is unknown where the DEA frontier is. Therefore, Chena *et al.* (2009) developed an approach to deal with it. Since the available software (Zhu, 2004) cannot deal with this issue, a single stage approach was used that included both the profitability and marketability. A multiple input-output DEA model can measure company performance much more comprehensively than any financial ratio, which is only a single-input-single-output measure. These previous studies will serve as a basis to develop a suitable DEA model to estimate the overall performance of companies under review.

However, in spite of a widespread adoption of measurements, such as market value ratios as dependent or independent variables and DEA efficiencies versus profitability ratios, there has been no empirical linkage between DEA and profitability ratios and market value ratios. Therefore, this study extends the current literature, by using both profitability ratios and market value ratios as independent variables, while DEA efficiency will be the dependent variable to indicate the importance of financial ratios relative to a firm's efficiency of using scares resources to create shareholders' wealth. Accordingly, this study will investigate 55 companies in three sectors on the JSE Limited over a five-year period to determine cross-sectional associations. The results of this study will indicate the relative importance of the different market value ratios and profitability ratios relative to the DEA efficiency. DEA will be used to estimate the annual technical efficiency of each company and Spearman's rank-order correlation analysis will be used to determine the relationship between these efficiency estimates and the different financial ratios.

3 Hypothesis

DEA is a technique for combining all the input and output data on the firm into a single measure of productive (in this case, technical) efficiency, which lies between zero (meaning the firm is totally inefficient) and one (which signals that the firm is fully efficient). The profitability ratios indicate a firm's profitability relative to sales, assets and equity, respectively. Thus, the higher the ratio, the more profitable the firm is. Market value ratios, such as price/earnings, price/cashflow, price/book value and price/net asset value, are an indication of what investors think about a firm's past performance and its future prospects. The higher these ratios, other things held constant, the higher the prospects or the lower the risk is, or both (Brigham & Ehrhardt, 2005:454-455). This is opposite to dividend yield, where a higher ratio indicates lower prospective and higher risk (Dunis & Reilly, 2004:231).

Therefore, the conceptual framework of the study is that the higher the technical efficiency (dependent variable) of a firm, the higher the positive relationship with the profitability and market value ratios is; except for dividend yield, where a negative relationship is expected.

If it is assumed that the more complicated technical efficiency indicates the overall performance of a firm, a high correlation with a specific readily available financial ratio (except dividend yield) will indicate that the ratio also has the ability to indicate the overall performance of a firm. A low or negative correlation between the technical efficiency and a specific ratio will indicate that the ratio does not have the ability to indicate a firm's overall performance, but that it only helps the investor to be trapped as the greater fool, i.e. where low performance firms (shares) are indicated to have high prospective and or low risk.

The conceptual framework will be helpful to test the following null-hypothesis:

> H_0: There is no monotone significant relationship between technical efficiency estimates of creating shareholders' wealth and the different financial ratios.

4 Data Envelopment Analysis (DEA)

DEA is a non-parametric linear programming technique that measures the relative efficiency of a comparative ratio of outputs to inputs for each decision-making unit, such as a firm (Ray, 2004:1; Avkiran, 1999:206). A firm is efficient "if it cannot produce more output without a corresponding relative increase in inputs, or if it cannot reduce its inputs without a corresponding relative decrease in outputs" (Thomas & Tripe, 2007:4). The traditional measurement of efficiency (or productivity) assumes only a single output divided by a single input (Cronje, 2002:33; Horngren *et al.*, 2009:517-518). The main advantage of using DEA as a relative efficiency measure is that it accommodates multiple inputs, multiple outputs and other factors in a single model (Halkos & Dimitrios, 2004:8). The main usefulness is its ability to identify inefficient firms, to generate potential improvement for them and indicate efficient firms that should be used as a benchmark by the inefficient ones (Avkiran, 1999:206).

DEA can be used to estimate four main types of efficiency, namely technical, allocative, economic and scale efficiency. In practice, the measurement of these efficiencies involves the estimation of production frontiers. DEA effectively estimates the frontier by finding a set of linear segments that envelop the observed data. Technical efficiency is an indication of how well inputs are converted into outputs, while allocative efficiency reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices (Avkiran, 1999:206-207; Oberholzer & Van der Westhuizen, 2009:69). A firm is economically efficient if it is both technically and allocatively efficient, and a firm is scale efficient if it operates on a scale that maximises productivity (Oberholzer & Van der Westhuizen, 2009:69). DEA can determine efficiencies from an input-orientated (input minimisation) or output-orientated (output maximisation) point of view (Avkiran, 1999:211; Oberholzer & Van der Westhuizen, 2009:75). Furthermore, analysts choose between using constant return to scale (CRS) or variable return to scale (VRS). The first implies a proportionate rise in outputs when inputs are increased, in other words, a firm's efficiency is not influenced by the scale of operations (Avkiran, 1999:211). "VRS implies a disproportionate rise or fall in outputs when inputs are increased" (Avkiran, 1999:211), in other words, if a firm grows in size, its efficiency will not stay constant, but it will either rise or fall.

The fundamental assumption of DEA is that if firm A (also known as a decision-making unit (DMU)) is capable to produce Y(A) units of output with X(A) inputs, then other producers should also be able to do the same if they were operated efficiently. The core of the exercise is to find the "best" virtual producer for each real producer and then compare the producer to its best virtual producer in order to determine its efficiency. The best virtual producer is found by means of linear programming (Anderson, 1996:2).

Analysing the efficiency of a number of DMUs requires a formulation of a linear programming problem for each DMU. "*lambda* is a vector describing the percentage of other producers used to construct the virtual producer. *lambda X* and *lambda Y* are the input and output vectors for the analysed producer. Therefore *X* and *Y* describe the virtual inputs and outputs, respectively. The value of *theta* is the producer's efficiency" (Anderson, 1996:2). The following is the DEA input-orientated primal formulation:

$$
\begin{aligned}
&\textit{Min} \quad && \theta, \\
&\text{s.t.} && Y\lambda \geq Y_0 \\
& && \theta X_0 - X\lambda \geq 0, \\
& && \theta \; free, \lambda \geq 0.
\end{aligned}
$$

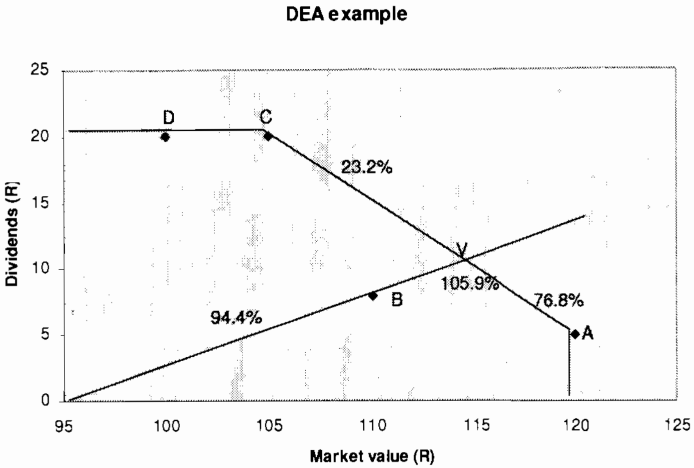
DEA will be explained by a single-input two-output, constant return to scale problem, because it is easy to analyse graphically. Table 1 exhibits the data:

Table 1
Single Input, two-output example

Firm	Input	Output	
	Book value of equity (R)	Market value of equity (R)	Dividends (R)
A	100	120	5
B	100	110	8
C	100	105	20
D	100	100	20

Firms A and C show the possibilities of virtual outputs that can be formed by them. Firm A is efficient (score = 1) to generate market value of equity, since no combination of B, C and D can produce market value of R120 with the constraint of only R100 book value of equity. Firm C and Firm D are efficient (score = 1) to pay dividends, since no combination of A and B can pay dividends of R20 with the constraint of only R100 of equity at book value.

Figure 1



In Figure 1, the line CA lies beyond CB or BA, which means that CA is the efficiency frontier where any combination of A and C will create the highest output for the given input. Firm B is below the efficiency frontier and therefore it is inefficient. The efficiency of B can be determined by its virtual firm (V) formed by Firms A and C. The virtual firm, that is the **benchmark** for B, is 76.8% of A (1 – AV/AC) and 23.2% of C (1 – VC/AC). This means that *lambda* = [0.768, 0.232]. The virtual vector output is now:

$$\lambda Y = [0.768 \times 120 + 0.232 \times 105, 0.768 \times 5 + 0.232 \times 20] = [116.5, 8.5]$$

From an output-orientated view, the efficiency of B is indicated by V, which means V can produce an output of 105.9 percent by using the same inputs of B. From an input-orientated view, the efficiency of B is the fraction of inputs that V would need (that is 0B = 94.4 percent of 0V) to produce the same output as B. Firm D is also on the efficiency frontier, but DC indicates a slack. That means D should move to point C.

5 DEA model

Avkiran (1999:214) gives a guideline when inputs and outputs are selected – the outputs should be the key business drivers that are critical to the success of the business, and the inputs should be the resources that lead to the key business drivers. Input variables or output variables can be related to each other, in other words, one variable may be a function of another variable. For example, both wages and the number of employees may be used as inputs and both sales and profit may be used as outputs (Ray, 2004:ix).

A combination of approaches was used to determine inputs. Assets, and in some cases only tangible assets or fixed assets, were used by Chen (2002), Oberholzer and Van der Westhuizen (2009), and Favero and Papi (1995). Shareholders' equity was used by Stavarek (2002), and Oberholzer and Van der Westhuizen (2009). Expenditure was used by Hassan Al-Tamimi and Lootah (2007), and Oberholzer and Van der Westhuizen (2009). In this study, tangible assets, shareholders' equity at book value and total expenditure are used as the input resources.

The reward that investors get from buying shares in a company is measured by the performance of two components, namely the cash component and the value component, which are the dividend payouts and the growth in the market value of the shares, respectively (Vigario 2005:10; Nel 2005:5). Growth (change) in market share value cannot be used as an output variable since it may take on a negative value as a result of the volatility in the market (JSE, 2009). The reason is that a DEA model requires positive data (Coelli, 1996; Zhu, 2004:266). Halme *et al.* (1998) also confirm that the most widely-used models by Charnes *et al.* (1978) and Banker *et al.* (1984) require that all the input and output data are strictly positive. Market value of shareholders' equity can be used as an output variable and that will be justified by the fact that its book value is used as an input. Market value was also used as an output by Seinford and Zhu (1999), and Chena *et al.* (2009). Profit can also be considered as an output, but the problem is that it also can take on a negative value. Therefore, sales revenue is used as an output to justify total expenditure as an input.

The following DEA model was specified:

Outputs: y_1 = Sales (Rand)

y_2 = Market value of shareholders' interest (Rand)

y_3 = Dividend payouts (Rand)

Inputs: x_1 = Total expenditure (Rand)

x_2 = Tangible assets (Rand)

x_3 = Book value of shareholders' interest (Rand)

The results of this model will give an aggregated measure of the operating efficiency (since sales is an output that is opposite to the input of scarce resources), profitability efficiency (since sales is an output that is opposite to total expenditure), and marketability efficiency (since the market value of shareholders' interest and [2]dividends as outputs is opposite to the inputs of the book value of shareholders' interest).

Note that the management of a firm does not have equal control with regard to the efficiency to reach the outputs, e.g. the management of a firm has much more control with regard to the operating and profitability efficiency than the marketability efficiency. But, this is not the point! This study is more concerned with how a firm's, and not management's, technical efficiencies are related to the financial ratios. Also note that market value is a component in all the market value ratios that will be compared to EVA in the empirical study.

6 Data sources and methodology

Companies use different year-end dates and performances are determined relative to these dates. The market volatility influences the market value of shares; therefore, share prices of companies with different year-end dates cannot be compared at year-end. Inflation may also influence values such as assets and shareholders' interest if the year-end dates are different. Therefore, only companies that use the same year-end dates will be grouped together.

Since differences can be expected between different sectors, it was decided to only include the following three sectors in the study rather than the whole JSE. The study includes Basic Materials (75), Industrials (70) and Consumer Goods (29). The reason for choosing these sectors is that they all have manufacturing of tangible products in common. Large sectors that are excluded probably differ substantially from these and they are Financial, Technological and Consumer Services. These numbers are taken from the Business Day (2009:20) only to indicate the scope of the study. The real population of the study will differ from year to year as a result of new listings and delisting.

In order to reach the first objective of the study, income statement, balance sheet and market data were used in the DEA model to calculate the input-orientated technical efficiency estimates for the selected companies. In total, 22 companies with December and 33 with June as their year-ends were included in the study. Companies with other year-ends than these do not provide a large enough sample to be investigated. The annual technical efficiencies for the companies in the two samples (22 and 33) were calculated relative to the other companies in that sample. The sample size of 22 and 33 observations is sufficient, according to Avkiran (1999:207-208), who states that it should be three times as large as the sum of the chosen variables, thus $22 > 3(3 + 3)$ and $33 > 3(3 + 3)$.

Data for the inputs included in the DEA model were taken from the balance sheet, i.e. Rand (book) value of total tangible assets and the Rand (book) value of shareholders' interest, and from the income statement, the Rand value of expenditure was taken. The outputs included were calculated by using the number of shares issued multiplied by the share price at year-end. This is to determine a company's efficiency that is only valid for the last day of its financial year. These efficiency estimates will then be compared to the financial ratios, also as calculated at the company's financial year-end. Furthermore, the outputs Rand value of sales and the Rand value of dividend payouts are taken from the income statement.

Data are taken for a five-year period, from 2004 to 2008. Note that no comparison will be made over the five-year period, but only between the 55 companies in each year. A five-year period is used to determine whether the results are consistent among the years.

The software package of Zhu (2004) is purpose-built to solve the DEA problem and has been used in this paper to generate estimates of annual input-orientated technical efficiency for each company over a five-year period. The input-orientated approach promotes an emphasis to cutting input expenditure, capital and tangible assets rather than expand sales, market value and dividend payouts. Although all the companies in the sample are involved in manufacturing, the variable return to scale approach is used rather than the constant return to scale approach, because of the divergent operations of the companies.

In this study, the following DEA formulae were used for an input-orientated model with a VRC approach. This is where the inputs are minimised, while the outputs are kept at their current levels (Zhu, 2004:5-13):

$$\min \theta - \varepsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+\right)$$

$$subject\ to$$

$$\sum_{j=1}^{n} \lambda_j \chi_{ij} + s_i^- = \theta \chi_{io} \qquad i = 1,2,\ldots,m;$$

$$\sum_{j=1}^{n} \lambda_j \gamma_{rj} - s_r^+ = \gamma_{ro} \qquad r = 1,2,\ldots,s;$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$\lambda_j \geq 0 \qquad j = 1,2,\ldots,n.$$

The input-orientated formula calculates input minimisation (where θ indicates the efficiency score). Each observation, DMU_j (j = 1, ..., n), uses m inputs X_{ij} (i = 1, 2, ...,m) to produce s outputs Y_{rj} (r = 1, 2, ...,s), and where DMU_o represents one of the n DMUs under evaluation, and X_{io} and Y_{ro} are the ith input and rth output for DMU_o, respectively. In order to consider any slacks, the presence of the non-Archimedean ε effectively allows the minimisation over θ to pre-empt the optimisation involving the slacks, s_i^- and s_r^+. [For a more detailed discussion on the DEA methodology, see Cronje (2002), Avkiran (1999), Ray (2004) and Zhu (2004).]

To reach the second objective, market value ratios and profitability ratios were taken from the McGregor database. Although financial models rely heavily on normality of data, Melas and Ruban (2009) proved that financial data are not normally distributed. Since, normality is a prerequisite for Linear Regression Analysis (Levine *et al.*, 2008:530), Spearman's correlation will be used to determine the degree in which technical efficiency will change if there is a change in the financial ratios. The rank order correlation of Spearman may be used to determine whether there is a monotone dependence between each of the eight independent variables (financial ratios) and the technical efficiency. Rank order correlation is a non-parametric technique for qualifying the relationship between two variables. Non-parametric means that the correlation statistics are not affected by the type of mathematical relationship between variables, unlike the least square regression analysis that requires the relationship to be linear (Vose, 1996:33). The Spearman rank order correlation coefficient is a more general measure of any kind of monotonic relationship between x and y. This measure is based on ranks and therefore not as sensitive for outliers (Millard & Neerchal, 2001:534). Regression analysis with one independent variable requires a sample of at least ten observations (Sekaran, 2006:294-297; Hanke *et al*, 2001:73). Each sample provides 22 and 33 data-points per year.

Finally, the null-hypothesis is tested by using p-values at one, five and ten percent significant levels.

7 Empirical results

The input-orientated technical efficiency of the companies under review was determined, and as a result of space restriction only the results of the 22 companies with a December year-end will be shown as well as the annual averages of the 33 companies with June year-ends. Table 2 indicates the relative efficiency of how the inputs (scarce resources) are converted to outputs that create shareholders' wealth. Six of the 22 companies (AMS, HVL, GND, ILA, MOB and PMV) were fully efficient during the period 2004 to 2008.

Table 2

Input-orientated technical efficiency of companies, 2004-2008

December year-end companies (n = 22)						
Company	**2008**	**2007**	**2006**	**2005**	**2004**	**Avg.**
AFE	0.849	0.883	0.897	0.991	1.000	0.924
AFX	0.929	0.885	0.868	0.874	1.000	0.911
AMS	1.000	1.000	1.000	1.000	1.000	1.000
ANG	1.000	0.608	0.628	0.858	1.000	0.819
ACL	1.000	0.920	0.832	1.000	1.000	0.950
DTA	0.971	0.548	0.514	1.000	0.822	0.771
EXX	0.764	0.973	1.000	1.000	1.000	0.947
HVL	1.000	1.000	1.000	1.000	1.000	1.000
MRF	1.000	0.811	0.475	0.695	0.887	0.773
PAM	0.784	1.000	1.000	1.000	0.382	0.833
BSR	0.964	1.000	1.000	1.000	1.000	0.993
BEL	0.835	0.924	0.908	0.870	0.868	0.881
CNL	0.755	1.000	0.768	0.876	1.000	0.880
GND	1.000	1.000	1.000	1.000	1.000	1.000
HWN	1.000	1.000	1.000	0.869	1.000	0.974
ILA	1.000	1.000	1.000	1.000	1.000	1.000
MMG	0.934	1.000	1.000	1.000	1.000	0.987
MOB	1.000	1.000	1.000	1.000	1.000	1.000
PMV	1.000	1.000	1.000	1.000	1.000	1.000
TRE	1.000	1.000	0.528	1.000	0.957	0.897
MTA	0.834	0.872	0.841	0.773	0.952	0.855
TON	0.791	0.564	0.649	0.637	0.780	0.684
Average	0.928	0.909	0.859	0.929	0.939	0.913
June year-end companies (n =33)						
Company	**2008**	**2007**	**2006**	**2005**	**2004**	**Avg.**
Average	0.877	0.910	0.917	0.922	0.953	0.916

The meaning of these estimates is, for example the first listed company (AFE), that this company has on average a relative efficiency of 92.4 percent, which indicates that it could reduce the consumption of its inputs by 7.6 percent without reducing its outputs (Coelli *et al.*, 2005:166). The last company listed in the table (TON) is on average the most inefficient with an average estimate of 68.4 percent. It is also clear that there are variations of the technical efficiency between companies, as well as variations between the annual averages of the two samples. Also remarkable is that the total averages of the two samples over the five-year period are almost the same, namely 91.3 percent and 91.6 percent for the December and June year-end companies, respectively.

Table 3

Descriptive statistics of variables: Average 2004-2008

December year-end companies (n = 22)

	DEA	Profitability ratios			Market value ratios				
	TE	**PM**	**ROA**	**ROE**	**DY**	**PE**	**PB**	**PNAV**	**PCF**
Mean	0.91	10.35	17.03	13.00	9.14	7.69	2.48	2.53	6.70
Std error	0.02	2.68	2.86	8.88	2.93	3.14	0.34	0.38	1.23
Median	0.94	8.18	13.74	15.34	4.24	9.04	1.99	2.07	6.07
Std deviation	0.09	12.56	13.40	41.63	13.74	14.72	1.57	1.77	5.78
Variance	0	158	180	1733	189	217	2.5	3.1	33.4
Kurtosis	0.16	1.05	1.20	3.36	9.72	4.64	-0.21	4.62	2.22
Skewness	-0.94	0.47	0.98	-1.62	2.85	-0.81	0.50	1.88	-0.58
Range	0.32	58.26	56.55	174.93	61.13	80.06	6.01	7.94	27.39
Minimum	0.68	-16.2	-3.95	-99.01	0.00	-35.2	-0.62	0.37	-9.34
Maximum	1.00	42.11	52.61	75.92	61.13	44.87	5.39	8.31	18.05
Confidence	0.04	5.57	5.94	18.46	6.09	6.53	0.70	0.78	2.56

June year-end companies (n =33)

	DEA	Profitability ratios			Market value ratios				
	TE	**PM**	**ROA**	**ROE**	**DY**	**PE**	**PB**	**PNAV**	**PCF**
Mean	0.92	4.01	12.57	13.00	2.30	13.03	2.30	2.05	4.27
Std error	0.02	3.09	2.16	6.63	0.44	2.19	0.24	0.33	3.89
Median	0.94	4.30	11.70	18.75	1.40	10.75	1.97	1.96	8.01
Std deviation	0.10	17.74	12.38	38.08	2.53	12.57	1.39	1.88	22.35
Variance	0.01	315	153	1450	6.42	158.0	1.92	3.52	500
Kurtosis	4.28	9.52	1.50	19.15	0.08	3.95	5.40	8.46	9.45
Skewness	-1.90	-2.40	-0.37	-4.10	0.97	1.79	0.14	-2.19	-0.65
Range	0.43	102.6	60.3	220.3	9.09	59.9	8.98	11.10	159.6
Minimum	0.57	-70.4	-21.5	-174	0.00	-6.59	-2.2	-5.53	-79.8
Maximum	1.00	32.29	38.83	46.42	9.09	53.3	6.76	5.57	79.8
Confidence	0.03	6.29	4.39	13.50	0.90	4.46	0.49	0.67	7.93

Table 3 is the descriptive statistics of the data, for the two samples of companies investigated, which were also used in Table 4 to determine the relationship between the technical efficiency estimates and the financial ratios of the two samples, respectively. Except for the mean (arithmetic average) and the median (50^{th} percentile), all the other descriptive statistics in Table 3 explain the reliability of the mean or median. The standard error indicates how the data differ from the total population if it is assumed that all the data of the population will form a normal distribution curve. The sample variance shows how the data is spread around the mean and the standard deviation is a standardised method to show how the data is spread around the mean. Skewness and kurtosis indicate the shape of the distribution curve, e.g. if the skewness is positive the curve has a long "tail" to the right and the mean is larger than the median. A normal kurtosis has a coefficient of zero where a negative kurtosis indicates a flat curve and a positive one a high peak. The confidence level is calculated at 95 percent, which indicates that the relevant variable will be 95 out of 100 times falling between the boundaries of the mean ± the confidence level score.

In Table 3, no adjustments were made for outliers. It is clear that there are differences between the means and the medians (and in some cases huge differences, e.g. the dividend yield of the first sample). This is probably the result of some outliers, large variances and a lack of normality of the data. There are also some major differences between the means of the two samples, e.g. the dividend yield of the two samples. The latter will not be addressed since the issue is not to compare the means of the two samples, but only to determine independently whether there are differences when the financial ratios are compared to the technical efficiency in each sample. The first issue was expected (see par 6), therefore Spearman's correlation coefficient is used.

Table 4 indicates that the highest and lowest correlation is between technical efficiency and the total return on equity ratios (75.8 percent) of the June year-end companies and the 2005 price/cashflow ratio (-63.7 percent) of the December year-end companies, respectively (the latter is also the only negative significant relationship). Note that the expectation, as explained in the conceptual framework, is that there should be a positive relationship between technical efficiency and all the financial ratios, except dividend yield, where a negative relationship was expected. This means that for example, in the 2004 results of the June year-end companies, the -0.239 correlation coefficient of dividend yield is higher ranked for example than the 0.237 of return on assets. To test the null-hypothesis, namely that there is no monotone significant relationship between technical efficiency estimates of creating shareholders' wealth and the different financial ratios, the p-values related to

Table 4

Spearman's rank-order correlation between technical efficiency and profitability and market value ratios

December year-end companies (n = 22)								
	Profitability ratios			Market value ratios				
	PM	ROA	ROE	DY	PE	PB	PNAV	PCF
2008	0.313	0.486**	0.486**	0.035	-0.318	0.183	0.309	-0.024
2007	-0.236	0.415*	0.672***	0.011	-0.236	-0.039	0.080	-0.088
2006	0.023	0.471**	0.536**	0.070	0.088	0.267	0.452**	0.059
2005	0.396*	0.349	0.598***	0.057	-0.132	0.014	0.062	-0.637***
2004	0.473*	0.415*	0.438**	0.213	0.143	0.218	0.384*	0.061
Total	0.112	0.413*	0.592***	0.005	-0.160	0.238	0.378*	-0.070
June year-end companies (n = 33)								
	Profitability ratios			Market value ratios				
	PM	ROA	ROE	DY	PE	PB	PNAV	PCF
2008	0.113	0.441**	0.382*	0.252	0.008	0.279	0.352*	0.143
2007	0.132	0.300	0.698***	0.212	0.132	0.383*	0.303	0.088
2006	0.034	0.501**	0.690***	0.297	-0.216	0.033	0.159	-0.301
2005	0.241	0.446**	0.574***	0.152	-0.096	0.236	0.198	-0.035
2004	0.041	0.237	0.462**	-0.239	-0.120	0.318	0.333	-0.163
Total	0.129	0.398**	0.758***	0.132	-0.086	0.219	0.188	0.083

* Significant at 10% (two-tailed)

** Significant at 5% (two-tailed)

*** Significant at 1% (two-tailed)

the above-mentioned correlation coefficients were also be determined. The p-values, which is an indication with how much confidence the null-hypothesis is rejected or not rejected, was used to determine significant relationships. The null-hypothesis is rejected in some cases at a significance level of one, five and ten percent, where $\rho < \alpha = 0.01$, 0.05 and 0.10, respectively (two-tailed). It is also clear that return on equity has the most significant relationship with technical efficiency, followed by return on assets and to a lesser extent, price/net asset value, price/book value and profit margin. The other market value ratios have a very low correlation with technical efficiency.

Table 5 is an extension of Table 4, where the relationship between the technical efficiency and the financial ratios is ranked (after the opposite behaviour of dividend yield is taken into account). The results of the one sample group are to a great extent confirmed by the other one. Both sets of data (see totals) indicate the importance of the ratios in almost the same sequence, where in sequence of importance, return on equity and return on assets are the highest ranked and price/book value and price/net asset value are together in the third place. Both sets of data indicate that the three most unimportant ratios are price/earnings, price/cashflow and dividend yield.

Table 5

Ranking of the correlation between technical efficiency and profitability and market value ratios

December year-end companies (n = 22)									
	Profitability ratios			Market value ratios					
	PM	ROA	ROE	DY	PE	PB	PNAV	PCF	
2008	3	2	2	7	8	5	4	6	
2007	8	2	1	4	8	5	3	6	
2006	7	2	1	8	5	4	3	6	
2005	2	3	1	6	7	5	4	8	
2004	1	3	2	8	6	5	4	7	
Total	**5**	**2**	**1**	**6**	**8**	**4**	**3**	**7**	
June year-end companies (n = 33)									
	Profitability ratios			**Market value ratios**					
	PM	**ROA**	**ROE**	**DY**	**PE**	**PB**	**PNAV**	**PCF**	
2008	6	1	2	8	7	4	3	5	
2007	6	4	1	8	6	2	3	7	
2006	4	2	1	7	6	5	3	8	
2005	3	2	1	8	7	4	5	6	
2004	6	5	1	4	7	3	2	8	
Total	**5**	**2**	**1**	**8**	**7**	**3**	**4**	**6**	

8 Conclusion

This study investigated the annual performance of two sample groups of 22 and 33 companies listed at the JSE Limited in the Basic Material, Industrial and Consumer Goods sectors from 2004 to 2008. The purpose of the study was to firstly use Data Envelopment Analysis (DEA) to aggregate the performance (efficiency) of firms to convert scarce resources into outputs that create shareholders' wealth in a single measurement, and secondly, to determine the degree to which this mentioned performance (efficiency) is reflected in a number of readily available profitability and market value ratios.

The study concludes that the DEA model used is suitable to indicate in a single measurement the relative efficiency of firms to convert scare resources (e.g.

tangible assets, shareholders' interest and payments for resources such as labour, materials, equipment, transport, etc.) in sales, market value of shareholders' interest and dividends. Since all DEA models require positive data, these selected inputs and outputs are usually positive and will only be negative by exception, e.g. a bankrupt firm with higher liabilities than assets will have a negative book value of shareholders' interest. The results of this model also give an aggregated measure of the operating efficiency, profitability efficiency and marketability efficiency. Also important is that inefficient companies can also be identified and investigated further to detect the reasons for their poor performances. Furthermore, the efficient companies can be used as a benchmark for the inefficient ones.

The study also found, with regard to both sample that return on equity has the most significant relationship with technical efficiency, followed by return on assets, and to a lesser extent, price/net asset value and price/book value. The market value ratios, i.e. price/earnings, dividend yield and price/cashflow, have a very weak relationship with technical efficiency. The study also concludes that the efficiency of a company to convert resources into shareholders' wealth can easily be substituted by using the readily available return on equity, and to a lesser extent, return on assets. These two profitability ratios outperformed all the market value ratios, even while the DEA model and all the market value ratios have market value as a common component.

Price/book value and its variation price/net asset value are the market value ratios where some degree of correlation was found and they outperformed the other market value ratios of price/earnings, price/cashflow and dividend yield that have almost no correlation with the technical efficiency.

The practical implication of this study is that this model or similar models can be used to determine the relative efficiency of a firm's operations, profitability and marketability. Since the DEA results are not readily available, return on equity, and to a lesser extent return on assets, can be used as substitutes for DEA. With regard to the market value ratios, only price/book value and its variation price/net asset value provide some indication of a firm's relative operating, profitability and marketability efficiency. Ratios such as price/earnings, price/cashflow and dividend yield should be used by investors only as short-term market indicators as they are excellent aids for speculation purposes, but they tell nothing about the above-mentioned efficiency of a firm. Thus, using these ratios will be helpful in being the lucky fool, if you can get rid of the shares before the bubble bursts, or being the greater fool.

The value of this study is that it is the first where the technical efficiency, determined by DEA, which aggregated operating, profitability and marketability efficiencies, is used to determine the relative importance of not only profitability ratios, but also market value ratios. Further research is necessary, since the element of risk is not included in the DEA model. Variations of the DEA model can be used and compared to the results of this study and a more advanced DEA model can be developed for further analysis to also determine scale, allocative and economic efficiencies.

Endnotes

1. The Greater Fool Theory is based on making money through buying probable overvalued or questionable shares and to sell them to someone (the greater fool) who is willing to pay a higher price for them. Unfortunately, sooner or later the bubble will burst and someone will be the owner of shares that are worth much less than they were purchased for.
2. Warren Buffet, an American investor, businessman and philanthropist, was, in 2008, ranked by Forbes as the richest person in the world. In 2009, after donating 85% of his fortune, he was ranked second, behind Bill Gates (Wikipedia, 2010).
3. In the literature, there are different opinions with regard to the influence of dividend payments (cash component) on market values. One theory's point of view is that dividends lead to higher market values; a more radical theory's view is that it reduces value; and the middle-of-the-road theory, based on the work of Miller/Modigliani, is that dividends are irrelevant with regard to market value (Vigario, 2005:352; Correia *et al.* 2007:16-4).
4. The three different approaches of firm valuation are market value ratios (also known as multiples or relative valuation method), discounted cashflow method and contingent claims valuation method (Park & Lee, 2003).
5. According to the formula Equity = Assets – Liabilities, the net asset value (NAV), which is Assets – Liabilities, is the same as the book value of equity. However, the McGregor database calculates NAV as Tangible Assets – Current and Long-term Liabilities.

REFERENCES

Adams, F.G. 2002. *Macroeconomics for business and society*, Singapore: World Scientific Printers.

Anderson, T. 1996. A data envelopment analysis (DEA) homepage. [Online] Available from: http://www.emp.pdx.edu.dea/homedea.html/ [Accessed: 10 February 2009].

Avkiran, N. 1999. An application reference for data envelopment analysis in branch banking: Helping the novice researcher, *International Journal of Bank Marketing,* 17(5): 206-220.

Banker, R.D., Charnes, A. & Cooper, W.W. 1984. Some models for estimating technical and scale efficiencies in data envelopment analysis, *Management Science*, 30(9):1078-1092.

Barker, R. 2001. *Determining value: Valuation models and financial statements*, Essex: Financial Times/ Prentice Hall.

Baum, C.L., Saver, L. & Strickland, T. 2004. EVA, MVA and Compensation: Further Evidence, *American Business Review*, Jun : 82-87.

Beattie, A. 2009. Book value: Theory vs. reality. [Online] Available from: http://www.investopedia.com.

Brigham, E.F. & Ehrhardt, M.C. 2005. *Financial management: Theory and practice,* 11th Edition, Mason, Ohio: South-Western.

Business Day. 2009. Share tables guide: JSE Limited: 20, 15 Jul.

Capual, C., Rowley, I. & Sharpe, W.E. 1993. International value and growth stock return, *Financial Analysis Journal*, Jan.-Feb: 27-36.

Charnes, A., Cooper, W.W. & Rhodes, E. 1978. Measuring efficiency of decision-making units, *European Journal of Operations Research*, 2:429-444.

Chen, T. 2002. Measuring firm performance with DEA and prior information in Taiwan's banks, *Applied Economic Letters*, 9:201-204.

Chena, Y., Cookb, W.D. & Zhu, J. 2009. Deriving the DEA frontier for two-stage processes, *Production, Manufacturing and Logistics*, Elsevier.

Coelli, T. 1996. A Guide to DEAP Version 2.1, A Data Envelopment Analysis (Computer) Program, CEPA Working Paper 96/07. Armidale: Department of Econometrics, University of New England.

Coelli, T.J., Rao, D.S.P., O'Donnell, C.J. & Battese, G.E. 2005. *An Introduction to Efficiency and Productivity Analysis,* New York: Springer.

Correia, C., Flynn, D., Uliana, E. & Wormald, M. 2007. *Financial Management*, 6th Edition, Cape Town: Juta.

Cronje, J.J.L. 2002. Data envelopment analysis as a measure for technical efficiency measurement in banking – a research framework, *Southern African Business Review*, 6(2):32-41.

Dunis, C. & Reilly, D. 2004. Alternative valuation techniques for predicting UK stock returns, *Journal for Asset Management,* 5(4):230-250.

Fairfield, P.M. & Harris, T.S. 1993. Price-earnings and price-to-book anomalies: Test of an intrinsic value explanation, *Contemporary Accounting Research*, 9(2): 590-611.

Favero, C.A. & Papi, L. 1995. Technical efficiency and scale efficiency in the Italian Banking Sector: A non-parametric approach, *Applied Economics*, 27:385-395.

Halkos, G.E. & Dimitrios, S. 2004. Efficiency measurement of the Greek commercial banks with the use of financial ratios: A data envelopment analysis approach, *Management Accounting Research*, 15(2):201-224.

Halme, M., Joro, T. & Koivu, M. 1998. Dealing with interval scale data in data envelopment analysis, International Institute for Applied System Analysis. [Online] Available from: http://74.6.239.67/search/cache?ei=UTF-8&p=DEA+%26+negative +values&icp=1_[Accessed 1 Julie 2009].

Hanke, E.J., Wichern, D.W. & Reitsch, A.G. 2001. *Business forecasting*, 7th Edition, Upper Saddle River: Prentice-Hall.

Hassan Al-Tamimi, H.A. & Lootah, A.M. 2007. Evaluating the operational and profitability efficiency of a UAE-based commercial bank, *Journal of Financial Services Marketing*, 11(4):333-348.

Horngren, C.T., Datar, S.M., Foster, G., Rajan, M. & Ittner, C. 2009. *Cost accounting: A managerial emphasis*, 12th Edition, Upper Saddle River: Pearson / Prentice-Hall.

Investopedia. 2009a. Stock-picking strategies: Fundamental analysis [Online] Available from: http://www.investopedia.com/university/stockpicking/ stockpickin1.asp. [Accessed: 12 September 2009].

Investopedia. 2009b. Warren Buffet: How he does it [Online] Available from: http://www.investopedia.com/articles/01/071801.asp. [Accessed: 15 August 2009].

JSE. 2009. Customer relations: Company overview: Market statistics [Online] Available from: http://www.ir.jse.co.za/phoenix.zhtm/?c=198120 &p=irol-mktStat [Accessed: 29 July 2009].

Keys, D.E., Azamhuzjaev, M. and Mackey, J. 2001. Economic Value Added(R): A critical analysis, *The Journal of Corporate Accounting and Finance*, Jan-Feb:

65-71.

Kramer, J.K. & Peters, J.R. 2001. An interindustry analysis of Economic Value Added as a proxy for Market Value Added, *Journal of Applied Finance*: 41-49.

Levine, D.M., Stephan, D.F., Krehbiel, T.C. & Berenson, M.L. 2008. *Statistics for managers using Microsoft Excel.* 5th Edition, New Jersey: Pearson.

Megginson, W.L., Smart, S.B. & Lucey, B.M. 2008. *Introduction to corporate finance,* Australia: South-Western Cengage Learning.

Melas, D. & Ruban, O. 2009. Die opstelling van modelle van finansiële tydreekse, *Beleggingsinsigte (Bylaag in Fin Week)*, 23 Jul.: 18:22.

Millard, S.P. & Neerchal, H.K. 2001. *Environmental statistics with S-plus*, Boa Raton, Florida: CRC Press.

Nel, I. 2005. *Financial management: Study guide for MDTP 822,* Potchefstroom: North-West University.

Oberholzer, M. & Van der Westhuizen, G. 2004. An empirical study on measuring profitability and efficiency of bank regions, *Meditari Accounting Research*, 12:165-178.

Oberholzer, M. & Van der Westhuizen, G. 2009. Estimating technical and scale efficiency in banks and its relationship with economic value added: A South African study, *South African Journal of Accounting Research*, 23(1) : 67 - 86.

Park, Y.S. & Lee, J-J. 2003. An empirical study on the relevance of applying relative valuation models to investment strategies in Japanese stock market, *Japan and the World Economy*, 15(3).

Ramcharran, H. 2003. Estimating the impact of risk on emerging equity market performance: Further evidence on data from rating agencies, *The Multinational*

Business Review, 11(3):77-89.

Ramcharran, H. & Kim, D. 2008. Estimating the dynamic impact of financial liberalization on equity returns in Southeast Asian markets, *The Multinational Business Review*, 16(3): 101:118.

Rappaport, A. 1986. *Creating shareholders value: The new standard for business performance*, New York: Free Press.

Ray. S.C. 2004. *Data envelopment analysis: Theory and techniques for economics and operational research,* Cambridge: Cambridge University Press.

Seinford, L.M. & Zhu, J. 1999. Profitability and marketability of the top 55 US commercial banks, *Management Science,* 45(9): 1270-1288.

Sekaran, U. (2006) *Research methods for business: A skill building approach,* 4th Edition, Singapore: Wiley.

Stavarek, D. 2002. Comparison of the relative efficiency of banks in European transition economies, Proceedings of the D.A. Tsenov Academy of Economics 50th Anniversary Financial Conference, Svishtov, Bulgaria, 955-971, Apr.

Stewart, G.B. 1999. *The quest for value*, New York: Harper Business.

Thomas, D. & Tripe, D. 2007. An investigation into the efficiency of a bank's branch network using data envelopment analysis [Online] Available from http://www.melbournecentre.com.au/Finsia_MCFC/2007/DavidTripe_1 [Accessed: 12 June 2009].

Vigario, F. 2005. *Managerial finance,* 3rd Edition, Durban: LexisNexis.

Vose, D. 1996. *Quantitative risk analysis: A guide to Monte Carlo simulation modelling*, Chichester: Wiley.

Wikipedia. 2010. Warren Buffet [Online] Available from: http://en.wikipedia.org/wik/warren_Buffet. [Accessed: 29 January 2010].

Yeh, Q. 1996. The application of Data Envelopment Analysis in conjunction with financial ratios for bank performance evaluation, *Journal of the Operational Research Society*, 47:980-988.

Zhu, J. 2004. *Quantitative models for performance evaluation and benchmarking: Data envelopment with spreadsheets and DEA Excel Solver,* Massachusetts: Kluwer.