FINANCIAL MEASUREMENTS TO RANK FARMS IN THE NORTHERN CAPE, SOUTH AFRICA, USING DATA ENVELOPMENT ANALYSIS

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Abstract

Producers use financial benchmarking in agriculture to compare financial performance across production years and to compare competitors in the industry. This study determined whether Data Envelopment Analysis could be used to divide farms in the Northern Cape (South Africa) into different performance groups using financial measurements. Three enterprise groups (crop, mixed, and livestock) were benchmarked using Data Envelopment Analysis and subsequently divided into efficient or inefficient groups according to operating efficiency. Efficient farms had an operating efficiency score of one and inefficient farms less than one. Results indicated that Data Envelopment Analysis could be applied to determine efficient and inefficient farms according to financial results. An alternative benchmarking tool to compare the operating efficiency of one farm relative to similar farms included in the data set was thus provided. It is recommended that the Data Envelopment Analysis benchmarking model be used in conjunction with other models or established norms to provide accurate information and a comprehensive overview of financial performance.

Key words: farm management, Data Envelopment Analysis, financial benchmarking, financial measurements

1. Introduction

An effective method for executing and monitoring strategic and operational plans on a farm is very important to ensure success. These plans, which include the financial structure of the farm, provide a clear sense of the producer's objectives. To ensure the financial objective of the farm is met, producers must constantly evaluate and monitor the financial performance of the farm (Boehlje *et al.*, 1999*)*. Financial ratio analysis is considered to be a standard approach for evaluating financial performance (Ozcan & McCue, 1996). There are some useful financial measurements that when used collectively over time can provide much information about the financial performance of a farm (Ferris & Malcolm, 1999).

The Farm Financial Standards Council, U.S.A., developed financial guidelines for agricultural producers. These measurements are divided into five categories: liquidity, solvency, profitability, repayment capacity and financial efficiency. In each of these categories there are measurements that are referred to as the "Sweet 16" financial measurements (Crane, 2004). Blocker et al., (2003) illustrated the use of the "sweet 16" measurements to obtain norms for the measures where farm performance is divided into three groups, the top -, midpoint - and bottom performance groups to benchmark a farm's financial performance.

Benchmarking is an important tool that can assist farm managers to improve the performance of a business. Benchmarking is defined by Wilson et al., (2004) as a performance indicator that identifies a specific level of performance, which includes best practice performance. Benchmarking with financial measurements provide the performance measurements of the different financial categories of a farm. The measurements can then be compared with the performance measurements of other farms (Wilson et al., 2004). Benchmarking provides information that can be compared to past performances of the farm and can also be compared to other farms (Blocker et al., 2003). Financial benchmarking can be done by dividing the farms into two or more groups on the basis of their performance. In order to divide the farms into performance groups, norms and boundaries have to be established.

A linear mathematical method, the Data Envelopment Analysis (DEA), uses financial measurements of farms to benchmark performance. The DEA method is a nonparametric mathematical model that evaluates the relative efficiency of a group of decision makers based on their input use to produce outputs (Al-Shammari & Salimi, 1998). The DEA uses a linear programming technique to find a set of weights for each farm so that the efficiency score is maximised, but does not exceed a score higher than one (Sarafidis, 2002). Since the development of the original DEA model by Charnes et al., (1978), several extensions have been made. The Charnes et al., (1978) model assumed constant returns to scale, thus assumed a proportional increase in input use would result in a proportional increase in output. The first adjustment to this original model was made by Banker et al., (1984) who accommodated for variable returns to scale. Thus the assumption is that a proportional increase in input use would result in a less or more than proportional change in outputs. Although most of the application of DEA models focus on the use of absolute number variables there are however cases where researchers needed to use ratio variables as input data especially when the aim is to evaluate producers financial performance. This led to the development of a non-parametric model for financial ratios by Fernandez-Castro and Smith (1994), and has since been used by Al-Shammari and Salimi (1998), Feng and Wang (2000), Scheraga (2004), and Ablanedo Rosas (2010) to evaluate relative efficiencies using financial ratios.

This study used the financially based DEA model to evaluate the financial performance of agricultural producers from the Northern Cape, South Africa. The financially based DEA model was used to benchmark the producers based on their financial performance. To evaluate the usefulness of the financially based DEA model the DEA results were compared to results from Henning (2011). Henning divided farms from the cooperative area of 'Griekwaland Wes Korporatief Limited' (GWK) into three groups in order to determine their financial performance.

2. Literature review

Financial measurements highlight many factors that can cause unacceptable farm financial performances. Of these factors, some are not in the producer's control (Boehlje et al., 1999). The producer has several options to improve financial performance; the usefulness of these options will be reflected in the financial measurements.

2.1. Data Envelopment Analysis

Data Envelopment Analysis was used to determine the efficiency of ports and shipping industries by Tongzon (2001). Lin et al., (2005) used DEA to measure the efficiency of selected Australian and other international ports and a performance efficiency evaluation of the Taiwan's shipping industry. Results of Lin et al., (2005) indicated that performance evaluation for shipping industries can be more comprehensive if financial ratios are used. An innovative adopted version of DEA was used by Ablanedo-Rosas et al., (2010) to study the relative efficiency of Chinese ports. This study made use of a financial ratio based DEA approach and results indicated that the higher a port's efficiency ratio in relation to the corresponding ratio of other ports, the higher the efficiency of this specific port. Apart from shipping examples, DEA was also used as a financial performance index for hospitals (Ozcan & McCue, 1996). Al Shammari and Salimi (1998) and Avkiran (2011) applied DEA to determine the operating efficiency of banks. Both studies used financial ratios to determine the operating efficiency of banks. Min-Feng and Wang (2000) evaluated the performance of airlines and found that performance evaluation was more comprehensive if financial ratios were considered.

The DEA is a method that is widely used in agriculture for a variety of reasons. Fraser and Cordina (1999) used DEA to assess the technical efficiency of dairy farms in Northern Victoria, Australia. Rouse et al., (2007) also used DEA to benchmark the performance of dairy farms. These authors illustrated how DEA can be a useful tool for benchmarking in the dairy industry and how to examine the impact of environmental factors on farm efficiency.

2.2. Benchmarking

Benchmarking is a long-standing, highly developed practice that is used in the agricultural sector (Jack, 2009). Flemming et al., (2006), mention that benchmarking was developed as a farm management tool to detect areas where producers could increase their profit or performance by adopting the methods of their more successful peers. Benchmarking is a powerful management tool that can be used by agricultural producers to manage their risks and improve their profitability (Craven et al., 2011). According to Ferris and Malcolm (1999), benchmarking has a valuable role to play in the improvement of farm productivity and plays a role in farm standards to help identify weaknesses.

There are two types of benchmarking that can be used to analyse and interpret financial records. With historical benchmarking, producers must focus on the improvement of their own financial measurements and the discovery of possible problems (Blocker et al., 2003). The other type of benchmarking compares a farm to other similar farms. The best farm analysis must include accounting guidelines and both of the benchmarking options, namely historical data and similar farm benchmark (Blocker et al., 2003).

Accurate and complete information is needed when a benchmarking system is developed. Another important factor is the amount of information collected over a number of years that will adequately reflect the producer's situation. Yeager and Langemeier (2007) used a sample of Kansas farms and concluded that five years of data are necessary to benchmark similar production enterprise farms.

3. Methodology

The data used in the study was obtained from GWK agribusiness head office in Douglas, South Africa. GWK has a study group of producers in their Northern Cape trading area[1]. The financial statements from the study groups for the years 2004 to 2009 totalled between 76 and 85 farms. Data obtained from GWK included balance sheets and income statements. Only 38 farms were identified to have complete financial statements for the period 2005 to 2009 (5 years). The farms (identified by a number) were divided into three enterprise groups: livestock (9), crop producers (17) and mixed enterprise (12) as shown in Table 1.

[1] Barkley West, Douglas, Hopetown, Marydale, Modderrivier, Niekerkshoop and Prieska.

Table 1. Farm identification numbers, organised per enterprise (n = 38)

Mixed enterprise	Cop enterprise	Livestock enterprise
farm number		
2	4	30
3	5	32
6	8	34
7	9	40
15	13	43
18	14	45
22	16	49
25	17	50
31	20	54
33	21	---
35	23	---
61	24	---
---	27	---
---	29	---
---	38	---
---	44	---
---	69	---

The balance sheet and income statements provided enough information for analysis using the "Sweet 16" financial measurements as identified by the Farm Financial Standards Council (Hoag, 2009). For this study 14 of the "sweet 16" financial ratios were used to analyse the farms and are shown in Table 2 with border ratios for three performance groups as identified by Blocker et al., (2003). Only 14[2] of the 16 measurements were included in the study because information on depreciation was not included in the data set obtained from GWK.

A financial ratio based DEA model was used to rank the farms according to their operating efficiency. Every farm is seen as a decision-making unit (DEA). The DEA model combines multiple financial measurements, as indicated in Table 2, into a single measurement of operating efficiency. The output orientated financial ratio based DEA model with variable returns to scale is defined as follows:

Maximise Z_0

Subject to: $\sum_{n=1}^{N} \lambda_n r_{in} \geq z_0 r_{io} \qquad i=1,\ldots, m$

$$\sum_{n=1}^{N} \lambda_n = 1$$

$$Z_0 \geq 0; \;\; \lambda_n \geq 0 \; (n = 1, \ldots \ldots, N)$$

Where *Z0* indicates the ratio enlargement rate for *DMU0*, λ_n represents the multiplier weights that is used to determine the efficiency frontier. While *ri0* represents the observed measurement for *DMU0*. *N* refers to the total number of DMU's that is appraised on *m* financial measurements (Al-Shammari & Salimi, 1998).

The mathematical model is solved for every farm, and in this manner the relative operating efficiency is determined for each DMU in question (Ablanedo-Rosas *et al.*, 2010). The higher the estimated ratio enlargement rate (Z_0) the lower the level of efficiency. However, interpretation of the estimated Z_0 value can be confusing, therefore an easily interpretable efficiency score (α) was estimated as:

$$\alpha = 1/Z0 \qquad 1 \geq \alpha \geq 0$$

This efficiency score or α allows the ranking of the current DMU's (DMU0), where an efficiency score of one is considerd as efficient and any score less than one (α < 1) is inefficient (Ablanedo-Rosas et al., 2010). The optimisation model used to estimate the DMU's efficiencies was built in the General Algebraic Modelling System (GAMS). The optimisation model was

[2] Depreciation was omitted because different methods exist to calculate depreciation debt repayment ratio was not reliable and only a monetary value showing debt repayment capacity was included.

Table 2. Financial measurements used for estimation of the DEA, formulas to estimate financial measures border ratios for the top, mid and bottom performance groups

	Formules	Borders		
Liquidity		Top	Mid	Bottom
Current ratio	Current assets ÷ Current liabilities	>2>	2-1	>1>
Working Capital	Current assets - Current liabilities	?		?
Solvability				
Debt against assets	Total Liabilities ÷ Total assets	<30%<	30%-60%	<60%<
Equity against assets	Total equity ÷ Total Liabilities	>70%>	70%-40%	>40%>
Debt against equity	Total Liabilities ÷ Total Equity	<43%<	43%-150%	<150%<
Pofitability				
Return on Assets	NFI ÷ Total assets	>10%>	10%-5%	>5%>
Return on Equity	NFI ÷ Total equity	>5>	5%-1%	>1%>
Operating profit margin	NFI ÷ gross revenue	>35%>	35%-20%	>20%
Net farm income	Net farm income	?		?
Debt Repayment Capacity				
Capital debt repayment capacity	NFI from operations ± Miscellaneous revenue/expenses + non farm income - income tax + interest	?		?
Financial Efficiency				
Asset turnover ratio	Gross revenue ÷ Total assets	>40%>	40%-20%	>20%>
Operating expense ratio	Total operating expenses ÷ gross revenue	<60%<	60%-80%	<80%<
Interest expense ratio	Interest expense ÷ Gross revenue	<10%<	10%-20%	<20%<
Net income ratio	NFI ÷ Gross revenue	>20%>	20%-10%	>10%>

Source: FFSC, 2008; Blocker et al., 2003

solved 15 times, solving the model for three enterprise groups, once for every year over the five years. This provided data results for the five years to determine changes in performance for each of the farms. An operational efficiency comparison can be made between efficient and inefficient farms of the same enterprise. To compare the results from the financial ratio based DEA to the border measurements from Henning (2011) the percentage of measurements that were in the top third performance for each farm were calculated.

4. Results and discussion

One of the important factors to remember when using DEA was that the farms were compared relative to one another. A farm identified as inefficient or efficient was seen in context to the other farms in the same enterprise category. Farms were benchmarked according to the performance of overall measurements with other similar enterprise farms. An inefficient score did not always indicate that the farm was in danger of bankruptcy, but was just an indication that other farms had a more efficient financial performance. There will always be farms in the bottom, mid-point and top performance group as determined by the border measurements by Henning (2011). The reason for this is because the data is analysed over five years to determine the border values for each measurements.

4.1. Crop enterprise farms

The DEA results for crop enterprise farms are given in Table 3. Farms 13, 14 and 16 were identified as the most efficient over five years. Farms 14 and 16 had more than 50% of their measurements in the top performance groups over the five years. Farm 13 was in the top performance group only once (2007/08) during the five year period. Farm 20 was efficient for four of the five years with a score of 0.998 for 2004/05. The same results were found with Henning's (2011) benchmarking border measurements as indicated by the percentage of measurements in the top performance group. However during the 2004/05 year the percentage of measurement recorded is 28%. During 2004/05, the owner's withdrawals as a percentage of farm profit were very high and that led to decreased measurements. Farm 24 was considered inefficient during the first two years, however, this rating changed to efficient from 2006/07. The border measurement indicated an improvement from only 28% in 2004/05 to a 100% in 2007/08. There was once again a decrease

Table 3. DEA results for crop enterprise farms from 2004 to 2009 (n = 17) and percentage of measurements in the top performance group calculated from Henning (2011)

Farm No.	DEA Results					Percentage of measurements in top performance group				
	2004/05	2005/06	2006/07	2007/08	2008/09	2004/05	2005/06	2006/07	2007/08	2008/09
4	0.983	0.97	0.982	0.984	0.992	28.6%	35.7%	42.9%	42.9%	50.0%
5	0.99	0.917	0.937	1	0.878	28.6%	14.3%	28.6%	42.9%	35.7%
8	0.951	0.947	0.944	0.976	0.956	7.1%	7.1%	14.3%	50.0%	14.3%
9	0.981	0.901	0.895	0.921	0.956	35.7%	14.3%	14.3%	21.4%	35.7%
13	1	1	1	1	1	28.6%	35.7%	35.7%	78.6%	35.7%
14	1	1	1	1	1	64.3%	71.4%	85.7%	100.0%	71.4%
16	1	1	1	1	1	57.1%	50.0%	92.9%	71.4%	78.6%
17	0.819	1	0.993	0.966	0.986	0.0%	7.1%	42.9%	42.9%	28.6%
20	0.998	1	1	1	1	28.6%	78.6%	78.6%	71.4%	78.6%
21	0.885	0.891	0.937	0.981	1	0.0%	14.3%	0.0%	57.1%	42.9%
23	1	0.955	0.961	0.981	1	50.0%	28.6%	28.6%	64.3%	64.3%
24	0.986	0.997	1	1	1	28.6%	42.9%	78.6%	100.0%	92.9%
27	1	0.947	0.961	1	0.997	42.9%	28.6%	21.4%	57.1%	50.0%
29	1	0.947	0.984	0.982	0.983	7.1%	21.4%	57.1%	85.7%	64.3%
38	0.954	0.963	0.894	1	0.902	7.1%	28.6%	21.4%	50.0%	21.4%
44	0.961	0.943	0.96	0.941	0.908	14.3%	7.1%	35.7%	35.7%	21.4%
69	0.709	1	1	0.982	1	0.0%	57.1%	57.1%	14.3%	78.6%

in the number of measurements in the top performance group for the last year but the percentage still remained very high with 93% in this group.

Farms 4, 8, 9 and 44 were inefficient. Using Henning's (2011) technique these farms scored at the bottom or mid-point for each year. When the efficient scores were compared to Henning's (2011) benchmarking measurements most of the scores for farms 4, 8, 9 and 44 were at the bottom or bottom half of the mid-point performance groups. Not one of these farms had more than 50% of their measurements in the top performance group over the five years. When farm measurements were divided into their respective performance groups, the results could be compared to that of the DEA model. The farms identified as efficient by the DEA model were also the farms with the most measurements in the top performance groups or at least in the mid performance group.

4.2. Mixed enterprise farms

The DEA results for the mixed enterprise farms are given in Table 4. Only one mixed enterprise farm (25) was identified as efficient over the five years. Farm 25 was in a very good position when the analysis of each financial measurement was compared to the norms for the GWK mixed farms by Henning (2011). The percentage of measurements in the top performance group indicated the same results with more than 70% of measurements in the top performance group in all years except for 2004/05. Farms 7, 35, and 61 performed well during four production years, there were years when the number of measurements for these farms were lower and performed in the midpoint performance group.

There was only one farm (Farm 2) that never had a DEA efficiency score of one. When comparing the differences in farms that showed an efficient financial performance measure in one or two years to an efficiency in four or five years, the differences were clear. The farms identified as efficient over all five years were the top performers, or at the top of the midpoint performance group according to the cut-off measurements calculated by Henning (2011). There were years

Table 4. Efficiency score of the mixed enterprise farms from 2004 to 2009 (n = 12) and percentage of measurements in the top performance group calculated from Henning (2011)

Farm No.	DEA Results					Percentage of measurements in top performance group				
	2004/05	2005/06	2006/07	2007/08	2008/09	2004/05	2005/06	2006/07	2007/08	2008/09
2	0.959	0.994	0.909	0.946	0.917	7.1%	0.0%	0.0%	14.3%	7.0%
3	0.986	1	0.949	0.998	0.957	28.6%	28.6%	14.3%	35.7%	14.0%
6	0.959	1	1	1	0.978	14.3%	50.0%	64.3%	35.7%	21.0%
7	1	1	0.996	1	1	78.6%	50.0%	57.1%	71.4%	57.0%
15	0.935	0.952	0.944	0.996	1	21.4%	21.4%	35.7%	35.7%	36.0%
18	1	0.984	0.976	1	0.968	28.6%	28.6%	21.4%	85.7%	21.0%
22	1	1	0.962	1	0.988	28.6%	85.7%	14.3%	71.4%	43.0%
25	1	1	1	1	1	42.9%	78.6%	85.7%	78.6%	71.0%
31	1	1	0.971	1	0.942	42.9%	78.6%	21.4%	42.9%	43.0%
33	0.98	0.974	0.979	0.978	1	28.6%	28.6%	35.7%	28.6%	57.0%
35	0.992	1	1	1	1	28.6%	57.1%	71.4%	71.4%	57.0%
61	1	0.998	1	1	1	28.6%	28.6%	64.3%	35.7%	64.0%

where some farms showed a decline in efficiency, however they still remained in a very good performance position relative to the other mixed enterprise farms. This could also be seen in the number of years where the percentage of measurements was in the top performance group. The remaining farms were mostly in the midpoint or bottom performance groups. These farms were not in the top third of the mixed enterprise farm performance groups in the GWK trading region and would have to improve their performance to enter the top third.

4.3. Livestock enterprise farms

The DEA results for livestock enterprise farms are shown in Table 5. There were only nine livestock enterprise farms that were analysed of which four were efficient over all five years. All farms were efficient for at least one of the five years. Results for the livestock enterprise farms could be interpreted the same as for the crop and mixed enterprise groups. With the high number of efficient farms over all five years there were certain farms that had no measurements in the top performance group for certain years.

The farms that had an efficiency score of one in three years or less were in the bottom of the midpoint and bottom performance groups. These farms could still have measurements that were in the top performance group in any specific year, but most of the performance measurements were in the bottom performances of the enterprise group. There were variations in the percentages of measurements in the top performance group (number of top performance measurements), but the farms that were identified as being efficient performed better than those that had an inefficiency score from the DEA results.

Table 5. Efficiency scores of the Livestock enterprise farms from 2004 to 2009 (n = 9) and percentage of measurements in the top performance group calculated from Henning (2011)

Farm No.	DEA Results					Percentage of measurements in top performance group				
	2004/05	2005/06	2006/07	2007/08	2008/09	2004/05	2005/06	2006/07	2007/08	2008/09
30	1	1	1	1	1	64.3%	35.7%	57.1%	14.3%	43.0%
32	1	0.979	0.968	0.978	0.957	35.7%	21.4%	0.0%	21.4%	7.0%
34	1	0.963	0.966	1	0.991	64.3%	0.0%	35.7%	78.6%	29.0%
40	0.91	0.842	1	0.965	0.897	21.4%	0.0%	50.0%	42.9%	14.0%
43	1	1	1	1	1	28.6%	57.1%	64.3%	42.9%	36.0%
45	1	1	1	1	1	28.6%	42.9%	57.1%	35.7%	36.0%
49	1	1	1	1	1	35.7%	92.9%	100.0%	78.6%	71.0%
50	1	1	1	0.995	1	35.7%	78.6%	85.7%	42.9%	57.0%
54	0.976	1	0.969	0.957	1	35.7%	21.4%	0.0%	0.0%	57.0%

4.4. Differences between inefficient and efficient farms

The question arose as to why some farms were more efficient than others. The average financial ratios for debt against assets, equity against assets, asset turnover ratio and net income ratio, over the five years, for efficient and inefficient crop-, mix- and livestock enterprise farms are shown in Table 6. The difference in performance was explained by the financial factors: capital structure (leverage), efficiency (asset turnover ratio) and net income. Thus, the financial structures of the farms differed.

Table 6. Average financial ratios for debt against assets, equity against assets, asset turnover ratio and net income ratio for efficient and inefficient crop-, mix- and livestock enterprise farms

Financial status	Crop farms (n = 17)		Mixed farms (n = 12)		Livestock farms (n = 9)	
	Efficient	Inefficient	Efficient	Inefficient	Efficient	Inefficient
Debt against asset	22%	29%	22%	29%	3%	16%
Debt against equity	30%	87%	30%	48%	4%	20%
Asset turnover	62%	51%	58%	44%	28%	24%
Net income ratio	43%	33%	40%	36%	73%	57%

The capital structure between efficient (22%) and inefficient (29%) crop enterprise farms was compared (Table 6) and the efficient farms were less reliant on borrowed capital

Asset turnover ratio indicated how effective assets had been used to generate income. The difference between the farms that were efficient and those that were inefficient were 62 against 51%. Another ratio that indicated the difference between the efficient and inefficient farms was the net income ratio, which indicated how much of the gross value of production was left after all farm expenses had been paid. The difference in average net income ratio for the efficient and inefficient farms was 10 percentage-points, with a 43% average for efficient farms and 33% for inefficient farms.

Differences between efficient and inefficient mixed enterprise farms were similar to those of crop enterprise farms. The difference in capital structure was, as shown in Table 6, viewed as the average debt against assets, debt against equity, asset turnover ratio and net income ratio. The results shown in Table 6 indicated that the efficient farms had more equity than borrowed capital in their capital structures, with borrowed capital being half the value of equity (efficient farms: 30%, inefficient farms: 48%). The efficient farms (58%) also used their assets more effectively with higher asset turnover ratios, which reflected in the net income ratios difference between the efficient (40%), and inefficient farms (36%).

The capital structure of livestock enterprise farms varied from crop and mixed enterprise farms (Table 6). This confirmed that different enterprises should not be compared, because results could be based and lead to mistakes during decision-making. The borrowed capital, debt against assets for efficient (3%) and inefficient (16%) livestock farms was lower than for the other enterprise farms. The difference in capital structures was also seen in the average values of efficient and inefficient farms, with debt against assets and debt against equity values much lower than those of crop and mixed enterprise farms.

The income that was generated by efficient farms were higher than for other farms, and this was reflected by the higher net income ratios (efficient farms: 73% and inefficient farms: 57%).

5. Conclusion and recommendations

The financial ratio based DEA model was applied to the South African agricultural sector, specifically the producers of the GWK trading region, Northern Cape to benchmark the financial performance. The DEA model was applied to three different enterprise groups over a period of five years and results indicated that the DEA model could be used successfully to benchmark agricultural producers.

In comparison the DEA model presented similar results to the performance groups determined by Henning (2011). Farms that were identified as being efficient by the ratio based DEA model was also the farms that had a high percentage of Henning's (2011) measurements in the top performance group. There were instances were measurements was not in the top performance group but in the mid-point performance group. Farms classified as DEA inefficient were in the bottom performance and the bottom half of the midpoint performance groups. These results indicated that the DEA model could be used as a financial measurement benchmarking tool to analyse the financial performance of farms. The methods of benchmarking could be used by producers to improve their decision-making and to identify specific regions of their financial structures that must improve.

The financial ratio based DEA and Henning's (2011) benchmark measurement should not be viewed as substitute benchmarking techniques but rather as supplement techniques. Henning's (2011) benchmark measurement technique compares the various financial measures to the financial norms whereas the DEA compares the financial measures of producers and determines the actual benchmark as represented by the best producers.

Producers within the same enterprises and not in different enterprises must be compared. The financial structures between the enterprises are different, making comparisons between the enterprises inappropriate.

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