THE 56TH ANNUAL CONFERENCE OF THE AGRICULTURE ECONOMICS ASSOCIATION OF SOUTH AFRICA

25 - 27 September 2018 | Lord Charles Hotel | Somerset West

Measuring the financial efficiency of agricultural cooperatives in South Africa: An application of the Simar–Wilson methodology

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The SA government has favored cooperatives over other types of corporate entities in its programmes for rural development. This study examines financial efficiency and its determinants for 387 agricultural cooperatives in SA using a two-stage double bootstrap approach. Bias-corrected Data Envelopment Analysis (DEA) efficiency estimates are obtained in the first-stage for the agricultural cooperatives. Next, a Double Bootstrapped Truncated Regression model was estimated to obtain bias-corrected scores. The model was designed to obtain DEA scores for financial efficiency. First-stage results indicate that many agricultural cooperatives are relatively inefficient. Results of the second-stage analysis identified significant determinants of efficiency as age of cooperatives, size, gender of management, governance indicators and training. Governance indicators negatively influencing efficiency indicate institutions that prioritize non-financial goals and consequently compromise on governance quality. The deviation from institutional control mechanisms most likely emerges in a weak institutional environment. Various types of training influenced financial efficiency meaning that an understanding of training needs across institutions is crucial for equipping and empowering cooperatives towards financial efficiency. The study shows that the design and implementation of suitable training programs are prerequisites for addressing financial efficiency of agricultural cooperatives.

Key words: Agricultural cooperatives, Data envelopment analysis, Financial efficiency, Two-stage double bootstrap method, South Africa

JEL codes: Q10, Q12, Q13

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Introduction

Cooperatives have earned a significant place as drivers for agricultural growth and rural development initiatives in many developing countries (Nganwa, Lyne and Ferrer 2010). According to Ortmann and King (2005) and Lyne and Collins (2008), such development and growth is achieved when cooperatives can facilitate smallholder farmers' access to input and product markets. The government of South Africa (SA) has put cooperatives at the forefront as organizations that are able to enhance the development of small-scale farmers and other similar institutions in rural communities (Ortmann and King 2007a, Chibanda, Ortmann and Lyne 2009). In this regard, the SA government has dedicated resources to providing a supportive legal environment for cooperatives by signing into law a new Cooperatives Act (No.14 of 2005), based on international cooperative principles. The new Cooperatives Act seeks to play an important role for cooperatives in promoting the economic and social development, mainly by employment creation, income generation, broad-based black economic empowerment facilitation and poverty eradication (Ortmann and King 2007a, Chibanda, Ortmann and Lyne 2009).

The SA government has favored cooperatives over other types of corporate entities in its programmes for rural development. A key piece of legislation to facilitate use of cooperatives or

vehicles for rural development (i.e. the new Cooperatives Act (No. 14 of 2005)), significantly changed the regulatory environment for cooperatives in SA. Since 2005, government programmes have resulted in the registration of a large number of agricultural cooperatives, whereas many of the larger cooperatives that existed pre-2005 have restructures as companies.

Nganwa, Lyne and Ferrer (2010), among others, were critical of government's decision to regulate the structure of cooperatives to be along the lines of traditional cooperatives. However, they felt that there was nonetheless sufficient flexibility to allow cooperatives to have institutional and organizational arrangements that created suitable incentives for successful business enterprise. Their concern was that many cooperatives would be structured with institutional and organizational arrangements that are likely to result in various free-rider problems that could prove detrimental to their chances of success.

Efficiency analysis at the unit level has emerged into a current important issue, because of the increasingly intense competition, globalization, and technological innovation around institutions (Stewart, Matousek and Nguyen 2016). Consequently, it is essential that researchers, development practitioners and policymakers are adequately informed when identifying genuine or possible problems affecting agricultural cooperatives. Such information is also important for making comparisons of competitiveness and efficiency of agricultural cooperatives. Inefficiency in the sector suggests that there could be opportunities for structural changes, increased competition to enhance the efficiency and productivity of agricultural cooperatives.

Wijesiri, Viganò and Meoli (2015) point out that the common methods used to measure efficiency include ratio indicators, and parametric and non-parametric methods. They add that financial ratios are known as one of the main traditional methods used in observing financial performance. Also, measuring efficiency based on these ratios is distorted and hence there is need to adjust the estimates obtained from these indicators. In addition, the ratios are argued to provide little help when examining the effects of economies of scale, the identification of benchmarking policies and the estimation of overall performance measures of firms. On the other hand, frontier methods used in measuring the efficiency of institutions (i.e. Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA)) have become more desirable methods to benchmark firms than traditional approaches.

Ortmann and King (2007a) point out the dearth of research on agricultural cooperatives in SA since 2000. Ortmann and King (2007b), Chibanda, Ortmann and Lyne (2009), Nganwa, Lyne and Ferrer (2010) are some of the other researchers who recently conducted studies on agricultural cooperatives in SA. Measuring financial or economic efficiency, and in particular the application of the Simar and Wilson (2007) approach, has attracted the attention of a number of researchers. Application of this methodology has recently made inroads into microfinance institutions (Wijesiri and Meoli 2015, Wijesiri, Viganò and Meoli 2015), airports (Barros and Dieke 2008) and banks (Fernandes Filipa Da, Stasinakis and Bardarova 2018, Stewart, Matousek and Nguyen 2016) research. However, the application of similar research in efficiency analysis of agricultural cooperatives has either failed to take off or attract the attention of researchers. Despite the priority given to agricultural cooperatives in SA and the available empirical research methods, this field remains under-researched. This scarcity of published literature provides an opportunity for further investigation of the determinants of efficiency of these institutions.

The objective of this paper is to research the variability in financial efficiency of agricultural cooperatives in SA. Identifying financial efficiency constraints is important if cooperative development is to be achieved in the future. This study will provide policymakers in the SA national and provincial departments of agriculture, the extension service, and other advisors with a more insight into the issues involved.

The use of deterministic DEA approaches has been criticized in previous empirical studies because of several well-known shortcomings. The use of a two-stage double bootstrap method has been suggested as a more preferable method. In this study, this approach is adopted following Wijesiri and Meoli (2015), Wijesiri, Viganò and Meoli (2015), Stewart, Matousek and Nguyen (2016) and Bibi et al. (2018). The estimator of the DEA efficiency is corrected for bias in the first-stage of the analysis by the use of the homogeneous bootstrap procedure (Simar and Wilson 2000). In the second-stage of the analysis, the bias corrected-efficiency scores are regressed on a set of independent variables by applying the truncated regression with bootstrap (Simar and Wilson 2007). According to Simar and Wilson (2007), the bootstrap approach provides meaningful conclusions as the method corrects for the bias and serial correlations of efficiency estimates thus providing valid inference.

Literature review on efficiency

No published studies have used either SFA or DEA to examine efficiency of agricultural cooperatives in SA. Nevertheless, these methods of determining efficiency have been used extensively in studies of microfinance institutions (Wijesiri and Meoli 2015, Wijesiri, Viganò and Meoli 2015, Bibi et al. 2018), banks (Fernandes Filipa Da, Stasinakis and Bardarova 2018, Stewart, Matousek and Nguyen 2016, Du, Worthington and Zelenyuk 2018) and the transport (airline) industry (Barros and Dieke 2008) amongst others. Studies applying these methods have provided an adequate discussion of the application and the theory of DEA. However, it may also be useful to briefly review some of the literature on SFA applications in previous research.

In Mexico, a study by Paxton (2007) examined 190 semiformal institutions in the financial services sector using SFA. The technology, average size of the loan dispersed, outreach to rural areas and institutional age were determinants found to be positively linked to technical efficiency. In another study by Hermes, Lensink and Meesters (2011), which similarly applied SFA, researched the likely tradeoff between MFIs' efficiency and the outreach depth as the determinant. The findings reveal a negative relationship between outreach and efficiency. Also, Servin, Lensink and Van den Berg (2012) used SFA in analyzing technical efficiency of 315 MFIs. The results of these MFIs in 18 Latin American countries indicate that differences in the type of ownership (e.g. cooperatives and financial institutions) are associated with differences in efficiency.

Application of the DEA approach followed by a bootstrap procedure has recently gained popularity in research of MFIs. An example of this is drawn from a study by Wijesiri and Meoli (2015) where the DEA based on the Malmquist approach was used to investigate the productivity changes of 20 MFIs in Kenya between 2009-2012. The results indicate that MFIs experienced yearly average productivity growth of approximately 7%, which is largely attributable to

technology advances. In the second stage of the analysis, the results from the selected independent variables show that younger MFIs are more likely to have a higher productivity than their older counterparts.

Another example comes from a study of 36 MFIs in Sri Lanka by Wijesiri, Viganò and Meoli (2015). The two-stage double bootstrap approach was used to investigate the technical efficiency and its determinants. Financial and social DEA models were constructed, and DEA scores for each of this model were estimated. The results in the first stage show that many MFIs in Sri Lanka are not financially and socially efficient. The second stage results show that the significant determinants of financial efficiency are age and the ratio of capital to assets, whereas social efficiency was influenced by age, type of the institution and return-on-assets.

Similarly, Bibi et al. (2018) applied DEA followed by the double bootstrap truncated regression approach to investigate efficiency of South Asian MFIs. In their application of the Simar and Wilson (2007) approaching the first stage analysis results imply that these MFIs are less socially efficient than they are financially. The gender of employees, proxied by female loan officers, was the main factor identified positively influencing efficiency of MFIs'. Both financial and social efficiency were strongly associated with governance.

The use of the Simar and Wilson (2007) approach in investigating efficiency has grown in popularity in the banking literature as well. A short review of the empirical application of this approach in is summarized as follows. Fernandes Filipa Da, Stasinakis and Bardarova (2018) evaluated the efficiency of banks in Europe between 2007–2014. Their DEA model was based on the Malmquist Productivity Index to estimate the scores of the banks efficiency. The results of the peripheral European domestic banks in their study revealed significant determinants of efficiency (i.e. liquidity and credit risk) negatively associating with productivity. On the other hand, factors such as capital and profit risk positively influenced productivity.

Du, Worthington and Zelenyuk (2018) provide an example of application of the Simar and Wilson (2007) approach to panel data. Their study investigated the determinants of efficiency of Chinese banking institutions from 2006 to 2011. Results from the adopted approach show that bank efficiency is positively associated with an increased proportion of share of the assets. A decrease in the non-earning assets in total assets, and an increase in total equity positively associated with bank efficiency.

Stewart, Matousek and Nguyen (2016) study analyzed the efficiency of banks in Vietnam between 1999 and 2009. The results suggest that larger banks are more efficient than smaller banks. The type of financial institution, that is whether the entity is either a non-state owned or state-owned commercial banks, had an impact on efficiency. In particular, the former commercial bank type was found to be more efficient than the latter. The older the institutions were less efficient compared to the younger ones. Also, having larger branch networks led to the banking institutions having less efficiency.

From the brief literature review of studies that applied the Simar and Wilson (2007) approach, significant determinants influencing efficiency were identified. These are the age of an institution, institutional size, type of institution, gender of employees, institutional governance

indicators and credit risk. The review highlights various proxies for institutional size used across these studies and these include equity, liquidity, assets value, return to assets and profits.

Methodology

Data

Data are collected from the Co-operative Data Analysis System (CODAS) for 387 agricultural cooperatives for 2017. These cooperatives were selected from a database of 3197 cases. Cases with missing observations were omitted in the analysis. Permission to access the online data was obtained from the Directorate of Cooperatives and Enterprise Development. Data collection, cleaning and analysis was done between January and March of 2018. The Microsoft Excel data was loaded into Statistical Package for the Social Sciences (SPSS) and Stata software for analysis.

Selection of input and output variables

The general consensus in the literature suggests that in using DEA to estimate financial efficiency, labour (Stewart, Matousek and Nguyen 2016, Wijesiri and Meoli 2015, Wijesiri, Viganò and Meoli 2015, Bibi et al. 2018) and operating expenses (Bibi et al. 2018, Wijesiri and Meoli 2015, Fernandes Filipa Da, Stasinakis and Bardarova 2018) are some of the key input variables to consider. Also, studies by Bibi et al. (2018), Wijesiri and Meoli (2015) and Wijesiri, Viganò and Meoli (2015) considered estimating financial efficiency in the first stage of DEA. **Error! Reference source not found.** shows indicators of these input and output variables and how they are defined.

Table 1. Input and output variables used in the first-stage DEA model for financial efficiency for the current year (in Rands)

Specification	Indicators	Definition
Input variables	Labour expenses	Annual wage expenses
	Operating and Financial expenses	Annual operating expenditure
Output variable	Turnover	Annual turnover

The explanatory variables used in the second stage are presented in **Error! Reference source not found.**. The expected signs of these variables are shown, and this hypothesizes the effect of these variables on the measure of efficiency. The institution-specific variables such as the age, size, and type of institution were selected in the second stage. According to Wijesiri, Viganò and Meoli (2015), the age of an institution is a suitable proxy for experience and managerial ability. Wijesiri and Meoli (2015) and Bibi et al. (2018) determined a positive relationship between the age of an entity and financial efficiency. However, this was contrary to the negative relationship determined by Stewart, Matousek and Nguyen (2016). The age of the cooperatives in this study is expected to be positive. At some point, this positive relationship is anticipated to turn from positive to negative. This is captured by the square of the age of the cooperative.

Table 2. Explanatory variables used in the second stage model for financial efficiency and their expected sign on the measure of financial efficiency

Variable definition	Expected sign
Operating years of the cooperative since registration.	+
Square of operating years of the cooperative	-
Number of animals in piggery production.	+/-
Number of animals in poultry production.	+/-
Cooperatives' size of operations (PCA index)	-
Cooperatives' size of borrowings (PCA index).	-
Cooperatives' membership group size (PCA index).	+
Cooperatives' full-time employees (PCA index).	+
Cooperatives' male committee chairpersons and male managers.	-
Cooperatives' registered members with disability and attend general meetings (PCA index).	-
Cooperatives' part-time employees (PCA index).	+
Youth in management committees, in part-time employment, and are chairpersons (PCA index).	-
Youth managers (PCA index).	+
Employed members with disability and female members in management committees (PCA index).	+
Compliance with annual financial audits (Dummy variable that is equal to 1 if the cooperative complies; and 0 if otherwise)	-
Value added tax compliance (Dummy variable that is equal to 1 if the cooperative complies; and 0 if otherwise).	-
Profit tax compliance (Dummy variable that is equal to 1 if the cooperative complies; and 0 if otherwise).	-
Cooperative principles compliance (Dummy variable that is equal to 1 if the cooperative complies; and 0 if otherwise).	-
Accounting and bookkeeping compliance (Dummy variable that is equal to 1 if the cooperative complies; and 0 if otherwise).	-
Dummy variable that is equal to 1 if the cooperative has received Cooperative principles training and 0 otherwise.	+
Dummy variable that is equal to 1 if the cooperative has received farming training from Farm together Training Programme[a] and 0 if otherwise.	+
Dummy variable that is equal to 1 if the cooperative has received Cooperative finance training and 0 if otherwise.	+
Dummy variable that is equal to 1 if the cooperative has received Cropping, farming, and vegetable production training and 0 if otherwise.	+
Dummy variable that is equal to 1 if the cooperative has received Farming management training and 0 if otherwise.	+
Dummy variable that is equal to 1 if the cooperative has received Project management training and 0 if otherwise.	+
Dummy variable that is equal to 1 if the cooperative has received Control mechanisms training and 0 if otherwise.	+

Variable definition	Expected sign
Dummy variable that is equal to 1 if the cooperative has received Entrepreneurship training and 0 if otherwise.	+
Dummy variable that is equal to 1 if the cooperative has received Equipment repairs and maintenance and 0 if otherwise.	+

Note: + is positive, - is negative; [a] According to the Department of Agriculture, Forestry and Fisheries, DAFF (2012), Farm together Training Programme is a learning initiative whose main focus is geared towards supporting agricultural cooperatives by addressing a range of skills (e.g. governance, business skills, and business choices).

Theoretical and empirical evidence suggests that institutions with larger sizes, in the form of assets, reduce the costs associated with gathering and processing information. Stewart, Matousek and Nguyen (2016), Bibi et al. (2018) and Fernandes Filipa Da, Stasinakis and Bardarova (2018) suggest a positive relationship between this institution-specific variables and financial efficiency. In the present study, indicators of expenses and borrowings measuring size of the cooperatives were used. Hence, the relationship between these indicators of size and financial efficiency is expected to be negative. The other institution-specific variables, that is the type of intuitions, is expected to have either a positive or negative effect on financial efficiency. The study by Wijesiri and Meoli (2015) is uses the type of an intuition as a determinant of financial efficiency.

Bibi et al. (2018) posits that characteristics of a committee of an institution does provide suitable proxies that measure governance. In their study on the impact of gender and governance on microfinance efficiency, Bibi et al. (2018) determined a negative effect between financial efficiency and female committee. Governance indicators used in the present study are compliance with annual financial audits, cooperative principles, value added tax and profit tax, which are all hypothesized to have a negative relationship with financial efficiency. Latent variables capturing cooperatives committee characteristics were also selected as indicators for governance. These latent variables were estimated using PCA. One of the latent variables measured cooperatives' dimensions of youth in management committees, in part-time employment and are chairpersons. The second latent variable represented male committee chairpersons and male managers. These governance indicators were also hypothesized to be negatively related to the dependent variable.

Indicators for agency and group size were also considered. agency indicators were PCA indices; the first representing cooperatives' dimension of youth managers, and the second representing cooperatives' dimension of employed members living with a disability and female members in management committees. These agency indicators were both hypothesized to be positively affect the measure of financial efficiency. The group size indicator, also a PCA index, was hypothesized to positively relate to financial efficiency. In addition, the PCA index for cooperatives' dimension of members with disability who attend general meetings and are registered also measures the dimension of group size. These are hypothesized to negatively influence the measure of financial efficiency.

Employment indicators were also considered as indicators affecting the measure of financial efficiency. These were for PCA dimensions for full-time, part-time and for disabled employment. The *a priori* expectation was that these variables positively relate to the dependent

variable. The last set of indicators were for training are presented in **Error! Reference source not found.**. All the training variables were hypothesized to be positively related to the measure of financial efficiency.

Results

Error! Reference source not found. presents the summary statistics for all variables, used in the first and second stage models. The estimates of financial efficiency model for the first stage are built by assigning annual turnover as the output variable, and annual wage expenses and operating expenditure as input variables. These findings indicate that cooperatives in SA have operating expenditure more than double the value of their wage bill. Also, the average turnover for the cooperatives sufficiently covers the total expenses. The value of theta is 0.165 implying a relatively low average level of financial efficiency. Overall, these preliminary results show that although cooperatives in SA are able to cover their operating expenses on average, most of them have a relatively low level of financial efficiency.

Table 3: Descriptive statistics for efficiency evaluation using DEA

Definition	**Obs.**	**Mean**	**Std Dev**
First stage DEA model input variables			
Annual wage expenses (in thousand Rands)	410	84.00	597.00
Annual operating expenditure (in thousand Rands)	410	177.00	658.00
First stage DEA model output variable			
Annual turnover (in thousand Rands)	410	333.00	1,985.00
Financial efficiency score from DEA (theta)	410	0.1648406	0.1483336
Second stage explanatory variables			
Operating years of the cooperative since registration	391	9.18	14.43
Square of operating years of the cooperative	391	291.89	1,717.08
Number of animals in piggery production	410	56.72	1,037.98
Number of animals in poultry production	408	1,005.80	8,116.21
Cooperative size operations (PCA index)[a]	408	0.000000026	1
Cooperative size borrowings (PCA index)[a]	408	0.000000025	1
Group size (PCA index)[b]	410	0.00029	0.99984
Full time employees (PCA index)[b]	410	0.00012	0.99968
Male managers (PCA index)[b]	410	-0.0001	0.99986
Disability (PCA index)[b]	410	-0.00005	0.99996
Part-time employees (PCA index)[b]	410	0.000049	0.99994
Youth management committee (PCA index)[b]	410	-0.0003	1.00012
Youth managers (PCA index)[b]	410	0.000098	0.99978
Disability employment and female managers (PCA index)[b]	410	-0.00002	0.99988

Definition	Obs.	Mean	Std Dev
Annual financial audit (dummy)	408	0.35539	0.47922
Value added tax compliance (dummy)	408	0.31127	0.46358
Profit tax compliance (dummy)	408	0.42157	0.49442
Cooperative principles (dummy)	408	0.74265	0.43771
Accounting and bookkeeping (dummy)	408	0.59804	0.4909
Cooperative principles training (dummy)	408	0.74265	0.43771
Farming (cooperative) training (dummy)	410	0.13171	0.33859
Cooperative finance training (dummy)	410	0.03415	0.18183
Cropping, farming, and vegetable production training (dummy)	410	0.06341	0.24401
Farming management training (dummy)	410	0.00244	0.04939
Project management training (dummy)	410	0.00976	0.09841
Control mechanisms training (dummy)	410	0.03659	0.18797
Entrepreneurship training (dummy)	410	0.00244	0.04939
Equipment repairs and maintenance training (dummy)	410	0.00488	0.06976

Note: Obs. is the number of observations; Std Dev is standard deviation; [a] see equations 11 to 12; [b] see equations 3 to 10.

Error! Reference source not found. also provides the summary statistics for variables used in the second stage analysis where a lot of variation is observed. For instance, the average age of the cooperatives is under ten years, which may imply relatively young entities. On the other hand, the standard deviation for age of cooperatives is 14, suggesting the presence of older cooperatives in the agricultural sector. Most of the agricultural cooperatives (i.e. 301 of them) were between 1 and 10 years, while 23.03% were in the 11 to 118 years category.

Principal component analysis (PCA) was conducted on observable membership and cooperative size measures. The main reasons for using PCA are: to reduce the number of variates used in regression analysis; reduce the dimensions existing in these respective measures; and to remedy problems of multicollinearity (Jolliffe 2002). PCA is a data reduction technique that is often used to investigate the relationship between variables. Thus, a PCA takes X_1, X_2, …, X_p and computes linear combinations of these variables representing p dimensions or PCs (i.e. PC_1, PC_2,…,PC_3) that each all contain all p Xs and are uncorrelated. The following equation shows linear combinations of all p original variables X_1, X_2, …, X_p

$$PC_1 = a_{11}X_1 + a_{12}X_2 + a_{13}X_3 + \dots a_{1p}X_p \quad [1]$$

Where: a_{11}, a_{12}, a_{13}, …, a_{1p} are the component loadings estimated such that the first eigenvector captures as much variance in the p Xs as possible, subject to the condition that

$$a_{11}^2 + a_{12}^2 + a_{13}^2 + \dots a_{1p}^2 = 1 \quad [2]$$

This means that the variance accounted for by PC_1, that is its eigenvalue is as large as possible subject to this condition that is imposed in order to avoid increasing the eigenvalue of PC_1 simply by increasing one more of the $a_{1j}(j= 1….p)$.

Similarly, the subsequent PCs, that is second, third, fourth, and so on, are derived so that the variance that each of them account for as large as possible, but smaller than the first PC.

Descriptive statistics for the variables used to compute the membership of the cooperatives are presented in **Error! Reference source not found.**.

Table 4: Variables used to compute membership dimensions

Variables	**Mean**	**Std. Dev.**
Registered male members (MALEREG)	12.62	64.66
Registered female members (FEMREG)	16.66	90.12
Registered youth members (REGYTH)	3.78	25.74
Registered disabled members (DISREG)	0.34	2.41
Active male members (ACTMALE)	10.62	59.29
Active female members (ACTFEM)	14.31	81.88
Active youth members (ACTYTH)	3.51	25.67
Male members attended the recent AGM (MALEAGM)	9.44	58.56
Female members attended the recent AGM (FEAGM)	12.98	80.13
Male members attended the previous AGM (MAPRAGM)	8.57	58.03
Female members attended previous year's AGM (FEPRAGM)	12.31	79.99
Youth members attended previous year's AGM (YTHAGM)	3.25	25.21
Disabled members attended previous year's AGM (DISAGM)	0.25	2.05
Male members in management committee (MALEMCOMM)	2.22	2.23
Female members in management committee (FEMCOM)	3.29	2.12
Youth members in management committee (YTHMGTCOM)	0.62	1.29
Male committee chairperson (MALECOMCHR)	0.71	0.45
Female committee chairperson(FEMCOMCHR)	0.24	0.45
Youth committee chairperson (YTHCOMCHR)	0.02	0.2
Male manager (MALEMGR)	0.45	0.5
Female manager (FEMMGR)	0.08	0.26
Youth manager (YTHMGR)	0	0.05
Number of full time employees (NUMFT)	6.26	29.24
Male full-time employees (MALEFT)	2.96	16.16
Female full-time employees (FEMFT)	3.34	13.85
Youth full time employees (YTHFT)	0.91	4.08
Disabled full time employees (DISFT)	0.04	0.29
Male part time employees (MALEPT)	1.2	3.33
Female part time employees (FEMPT)	1.65	7.71

Variables	Mean	Std. Dev.
Youth part time employees (YTHPT)	0.44	2.18

Note: Std. Dev. is standard deviation; AGM is annual general meeting.

The PCs were extracted from the correlation matrix computed for the variables in **Error! Reference source not found.**. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were used to determine whether the dataset of the cooperatives could be factored. The KMO measure was 0.762 while the Bartlett's test of sphericity was statistically significant at $p<0.001$. According to Hair et al. (2006), KMO values greater than 0.5 and a statistically significant value for the Bartlett's test (i.e. $p<0.05$) indicate that the respective variables can be factored. Eight PCs had eigenvalue larger than one and accounted for 81.90% of variation in the data, following Jolliffe (2002). Varimax with Kaiser normalization rotation method was used to improve interpretation of the PCs. Therefore, these PCs were considered suitable indices to represent dimensionality in membership of cooperatives. The components are each a linear combination of the membership indices. The names of variables appearing on the left-hand side of the equations below, are described in **Error! Reference source not found.**. The first PC (i.e. GROUPSIZE_1) accounted for the largest variation of 35.17% in the total variance and signs for all the coefficients are positive. This suggests that aspects of group size expressed in the equation move very closely together and therefore the component measures variation in the series that occurs when these 11 characteristics of membership are moving in the same direction.

GROUPSIZE_1 = 0.988(FEAGM) + 0.984(FEPRAGM) + 0.980(ACTFEM) + 0.980(ACTYTH) + 0.978(REGYTH) + 0.977(YTHAGM) + 0.961(MALEAGM) + 0.960(MAPRAGM) + 0.958(ACTMALE) + 0.931(FEMREG) + 0.916(MALEREG) [3]

The second PC (i.e. FTEMPLOYEES_1), accounted for 12.69% of the variation in the data. Linear combinations of this PC are shown below. Signs of the variables are all positive and therefore suggests that indicators for full time employment generally moves very closely together. For instance, a cooperative with a high number of female full-time employees would have high numbers of total full time, male and youth employees.

FTEMPLOYEES_1 = 0.982(NUMFT) + 0.968(FEMFT) + 0.953(MALEFT) + 0.904(YTHFT) [4]

The third component was:

MALEMGT_1 = -0.877(FEMCOMCHR) + 0.834(MALECOMCHR) + 0.653(MALEMGR) - 0.652(FEMMGR) [5]

It accounted for 8.58% of the rotated summed variation. This linear combination in the principal component implies that a common positive association amongst male managers and committee chair including low female committee chairpersons and female managers, exist.

The fourth component describes the bond between cooperative members living with disabilities who are registered and attend annual general meetings. This PCs explains 6.56% of the variation in the membership indices.

$$DISABILITY\_1 = 0.946(DISAGM) + 0.938(DISREG) \quad [6]$$

The next PC points to a linear relationship among male, female and youth part time employees, and male committee members. This PC accounts for 6.19% of the variation.

$$PTEMPLOYEES\_1 = 0.836(MALEPT) + 0.757(FEMPT) + 0.510(MALEMCOMM) + 0.414(YTHPT) \quad [7]$$

The sixth PC, YTHMGTCOMM_1, accounted for 4.60% of the variation. Linear combinations of this PC suggest the existence of a common positive association amongst youth factors for management committee, chairmanship, and part-time employment.

$$YTHMGTCOMM\_1 = 0.739(YTHMGTCOM) + 0.620(YTHCOMCHR) + 0.451(YTHPT) \quad [8]$$

The seventh component was:

$$YTHMGT\_1 = 0.486(YTHCOMCHR) + 0.887(YTHMGR) \quad [9]$$

It explained 4.10% of the total variation. This PC captures variance caused when youth committee chair and youth managers are positive and move in the same direction.

The eighth PC accounted for 4.00% of the variation and it measures the variance that occurs when disabled full-time employees and female committee members move in the same direction.

$$DISEMPFEMMGT\_1 = 0.696(DISFT) + 0.570(FEMCOM) \quad [10]$$

Descriptive statistics for variables used to construct principal components for cooperative size are presented in **Error! Reference source not found.**.

Table 5: Variables used to compute cooperative size dimensions (Rands in thousands per annum for the previous year)

Variable	Observations	Mean	Standard Deviation
Expenditure (EXPENYR)	410	173.00	591.00
Turnover per (TURNYR)	410	367.00	1,785.00
Annual wages (WAGEYR)	410	57.00	179.00
Total owed to creditors (OWEDYR)	408	5.00	44.00
Outstanding Loans (banks) (LOANYR)	408	7.00	56.00

Similarly, the PCs for cooperative size were extracted from the correlation matrix of variables presented in **Error! Reference source not found.**. The KMO measure and Bartlett's test of sphericity, as described earlier, were also used in this instance. Use of Varimax with the Kaiser normalization rotation was also included. The KMO measure was 0.532 and Bartlett's test was statistically significant at $p<0.001$. Two dimensions of cooperative size were extracted and accounted for 71.80% of the variation in the cooperative size indices. Indices which had eigenvalue greater than one were COOPSIZEOP_1 and COOPSIZEBOR_2 described in **Error! Reference source not found.**. The first PC describes the relationship between turnover, expenditure, and annual wages of the previous year. This component explains 40.77% of the variation in cooperative size indices.

$$COOPSIZEOP\_1 = 0.877(TURNYR) + 0.855(EXPENYR) + 0.721(WAGEYR) \quad [11]$$

The second component points to a linear relationship between total money owed to creditors and outstanding loans to financial institutions.

$$COOPSIZEBOR\_2 = 0.889(OWEDYR) + 0.804(LOANYR) \quad [12]$$

Table 6: Simar and Wilson regression estimates for financial efficiency

Financial efficiency	**Coefficients**	**p-values**
Operating years of the cooperative since registration	**0.0140*** **	**(0.0014)**
Square of operating years of the cooperative	**-0.000122*** **	**(0.0022)**
Number of animals in piggery production	-0.0000167	(0.3168)
Number of animals in poultry production	-2.81e-08	(0.9912)
Cooperative size of operations (PCA index)[a]	**-0.0858*** **	**(0.0002)**
Cooperative size of borrowings (PCA index)[a]	**-0.0359***	**(0.0674)**
Group size (PCA index)[b]	0.00147	(0.9321)
Full time employees (PCA index)[b]	0.0115	(0.5542)
Male managers (PCA index)[b]	**0.0381***	**(0.0659)**
Disability (PCA index)[b]	0.0135	(0.4647)
Part-time employees (PCA index)[b]	-0.00508	(0.8313)
Youth management committee (PCA index)[b]	-0.0200	(0.2269)
Youth managers (PCA index)[b]	0.0204	(0.2904)
Disability employment and female managers (PCA index)[b]	0.0233	(0.1495)
Annual financial audit compliance (dummy)	**0.182*** **	**(0.0010)**
Value added tax compliance (dummy)	**-0.139*** **	**(0.0097)**
Profit tax compliance (dummy)	**0.0756***	**(0.0867)**
Cooperative principles compliance (dummy)	-0.0218	(0.6713)
Accounting and bookkeeping compliance (dummy)	**-0.0866***	**(0.0525)**
Cooperative principles training (dummy)	0.125	(0.5710)
Farming (cooperative) training (dummy)	**0.108** **	**(0.0405)**

Financial efficiency	**Coefficients**	**p-values**
Cooperative finance training (dummy)	**0.471***	**(0.0886)**
Cropping, farming, and vegetable production training (dummy)	-0.107	(0.2054)
Farming management training (dummy)	**-0.723***	**(0.0628)**
Project management training (dummy)	**-0.572****	**(0.0358)**
Control mechanisms training (dummy)	-0.326	(0.1533)
Entrepreneurship training (dummy)	0.375	(0.2597)
Equipment repairs and maintenance training (dummy)	**0.524***	**(0.0559)**
_cons	**-0.154****	**(0.0320)**
sigma	**0.218*****	**(0.0000)**
Number of observations = 384		
Number of efficient DMUs = 3		
Number of bootstrap. reps = 1000		
Wald $Chi^2(26) = 70.93$		
Prob > $Chi^2(26) = 0.0000$		

p-values in parentheses;* p<0.10, ** p<0.05, *** p<0.01;[a] see equations 11 to 12; [b] see equations 3 to 10

The Simar and Wilson regression model predicting estimates for financial efficiency was statistically significant (Chi-square = 70.93, p<0.001) (Table 6). The variable for the operating years of cooperative since registration is statistically significant at p<0.001. A unit increase in the years of cooperative in operation results in a 0.014 increase in predicted financial efficiency score. The square of operating years of the cooperative is also statistically significant at p<0.001 and is negatively related to financial efficiency score. Measures for cooperative size, i.e size of operations and size of borrowings, were both statistically significant at 1% and 10% levels of statistical significance and negatively related to financial efficiency measure. One of the indicator variables represents cooperatives' PCA dimension of male committee chairpersons and male managers is also statistically significant and positive at p<0.10. Variables for compliance with annual financial audits, value-added tax, and accounting and bookkeeping compliance were found to be statistically significant at the 1%, 1%, and 10% levels respectively. Compliance with annual financial audits was positively related to the financial efficiency score. This means that complying with auditing procedures leads to an increase in the financial efficiency score by 0.182. Complying with value-added tax leads to a decrease in the financial efficiency score by -0.139. Accounting and bookkeeping compliance leads to a 0.0756 increase in financial efficiency. Variables for training that were statistically significant and positively affecting the measure for financial efficiency were Farm together Training Programme, cooperative principles, and equipment repairs and maintenance at the 5%, 10%, and 10% level respectively. Training variables affecting financial efficiency score negatively were farming management and project management at the 10% and 5% levels of statistical significance respectively.

Discussion of results

The results in the first-stage analysis show that a large proportion of agricultural cooperatives in SA are relatively financially inefficient. Efficiency is measured relative to the most efficient cases in the sample. Therefore, a few highly efficient cooperatives can make the rest of the cooperatives appear bad. Likewise, the absence of highly efficient cases can make other units appear relatively more efficient than they really are. Several control variables reveal interesting relationships that link efficiency to age, size, and type of the institutions, gender of management, institution's governance, and training variables. Despite the absence of previous published studies on the efficiency of agricultural cooperatives in SA, this study is generally in line with findings of previous research. The age of agricultural cooperatives positively influenced the measure of financial efficiency. This is similar to results obtained by Wijesiri, Viganò and Meoli (2015), and Bibi et al. (2018), and contrary to findings by Stewart, Matousek and Nguyen (2016). Wijesiri, Viganò and Meoli (2015) explain that many entities find it difficult to break-even at the onset of their operations but improve as they get older. Therefore, older agricultural cooperatives would tend to be more financially efficient than younger ones. Wijesiri, Viganò and Meoli (2015) state that age is a suitable proxy for managerial ability. Hence, the implication of this may be that older agricultural cooperatives have better managerial ability. They also add that entities would possess a relatively high efficiency measure if they have improved management practices. Intuitively, better managerial ability leads to relatively financially efficient agricultural cooperatives. The positive relationship between financial efficiency and age is expected to turn from positive to negative at some point in time, and this effect is captured by the square of the age of the cooperative. This means that effect of age on the financial efficiency indicator lessens as institutions get older.

The effect of governance indicators on the efficiency measure revealed mixed results. Compliance with annual financial audits and profit tax appears positively significant for financial efficiency. This is consistent with findings by Bibi et al. (2018) and Müller and Uhde (2013). On the contrary, value-added tax, and accounting and bookkeeping compliance were negatively related to the financial efficiency indicator. Indicators negatively influencing financial efficiency, arguably represent weak governance as suggested by Barry and Tacneng (2014). More specifically, Barry and Tacneng (2014) make a strong case of point of weak governance, showing that financial institutions tended to relax some of the rules and procedures. A scenario where institutions relax rules and procedures usually arises when they pursue several and often competing objectives. As an example, institutions could follow social efficiency objectives that are likely to compete with financial efficiency objectives as illustrated by Wijesiri and Meoli (2015) and Bibi et al. (2018). Financial institutions observed by Barry and Tacneng (2014) leaned towards compromising governance quality in order to prioritize social objectives over financial goals. Therefore, the observed negative relationship between governance indicators and financial efficiency of agricultural cooperatives, may suggest that cooperatives are inclined towards relaxing some of their internal controls to accommodate other non-financial objectives. Boehe and Barin Cruz (2013) and Barry and Tacneng (2014) emphasize on importance and effect of institutional environment on incentives and behavior of both institutions and affiliates of those institutions. They mention that deviation from a rule of law, or institutional control mechanisms, tends to emerge in a weak institutional environment. Agricultural cooperatives in SA are perhaps operating in this kind of an environment. The Cooperatives Act (No.14 of 2005) has received criticism for not being fully capable of transforming the cooperatives sector in SA because of the problems created by the same Act. For example, one of the problems with the

cooperative model in SA was that its adoption was viewed as a precondition for receiving government support (Nganwa, Lyne and Ferrer 2010). Intuitively, some of the internal controls of cooperatives may have been established based on the expectation to receive government support. In such a case where this support is not forthcoming, it may create a situation where several formalized institutions according to this legal framework are not benefiting from the expected assistance. In other words, there would be an establishment of an economy with formalized agricultural cooperatives involved in informal activities. Perhaps involvement of cooperatives in informal activities would be for economic survival. According to Quintin (2008), a weak rule of law may indicate a large economy characterized by informal activities. Quintin (2008) reveals that group consensus of institutions seeking to achieve financial gain may prevent the taking up of marginal opportunities or taking onboard members whose contribution, financially or otherwise, is considered inadequate. Nganwa, Lyne and Ferrer (2010) point out that some agricultural cooperatives shed off their poorest members and create their own rules to reward investments and contributions made by members to the cooperatives. This is in line with Barry and Tacneng (2014) who ascertain that shareholder-owned institutions have a tendency to benefit from good quality governance practices. In such a case, the rule of law appears strong and relation-based exchanges are less important.

Evidence emerging from gender literature suggests that involvement of women in management and executive designations, such as board members, leads to an improvement in organizational performance (Strøm, D'Espallier and Mersland 2014). Beck, Behr and Madestam (2018) and Bibi et al. (2018) find that female officers have a positive impact on financial efficiency. Indicators for female employees and management in this study were found having no significant impact on efficiency contrary to Strøm, D'Espallier and Mersland (2014). Bibi et al. (2018) also observe that female management have no significant impact on the efficiency scores. However, findings in the present research indicate that male management positively affect efficiency. In the context of agricultural cooperatives in SA, this observed effect of male managers on efficiency may support the arguments that men have a higher ability as leaders than women in achieving financial objectives.

Wößmann (2008) posit that efficiency of education training systems can be improved by reforms oriented towards output productivity. In addition, these reforms perform optimally in a well-regulated environment geared towards accountability. Financial efficiency used in the present study, and by researchers such as Wijesiri and Meoli (2015), Wijesiri, Viganò and Meoli (2015), Stewart, Matousek and Nguyen (2016) and Fernandes Filipa Da, Stasinakis and Bardarova (2018), provides a representation of the measure of productivity. Therefore, the same argument can be applied to agricultural cooperatives in the sense that training members may improve productivity or financial efficiency of agricultural cooperatives. In fact, Dearden, Reed and Van Reenen (2006) identify work-related training as one of the key factor responsible for increasing productivity. Training in areas such as use of equipment, repairs and maintenance was found to positively influence financial efficiency. Also, cooperative finance training and training offered by the Farm together training programme were found to positively impact efficiency. On the contrary, there were other training variables which negatively affected efficiency. These were farm management and project management training. Green (2000) presents two assertions which may support why such a negative relationship between the training variables and efficiency is observed. Firstly, organizations usually bankroll employee training, but this kind of expenditure

does not necessarily translate to increased wages for employees. Corporate expenditure on employees in the short run seems to generally improve work performance. Later on, the training acquired by employees makes them desirable to other institutions. Also, training and acquiring relevant experience positions employees for better opportunities on the job market. Secondly, gaining of human capital may not necessarily lead to staff retention. Rather, such a gain may lead to an increase in staff leaving organizations.

Conclusion

This paper examines the financial efficiency and its determinants of 387 agricultural cooperatives in SA. A DEA model is constructed to capture financial efficiency scores of these cooperatives. The contribution of this paper is two-fold. Firstly, agricultural cooperatives in SA are relatively under-researched, given the resources employed towards their success by the SA government, and also the role that cooperatives play in agricultural development. Secondly, new empirical research methods have gained popularity among researchers in other sectors, but little research appears in publication with respect to agricultural cooperatives. Application of the Simar and Wilson (2007) approach to obtain financial efficiency measure of agricultural cooperatives, was adopted in the present research. First-stage results reveal that a great number of cooperatives are relatively financially inefficient. Furthermore, results of the second-stage regression show that older cooperatives are more financially efficient compared to younger organisations. This is consistent with the fact that, while many entities, and in this case cooperatives, find it challenging to break-even at the onset, they are better able to do so when they increase in size and improve on their management processes over time. The reasoning presented for accepting borrowings and operation costs as measures of size is that as the asset base grows, an establishment will have operating expenses and the level of borrowing increases as well. Although proxies used for the measure of size have a negative relationship with the measure for efficiency, the relationship intuitively suggest that cooperatives become financially efficient as their size increases. The second-stage regression results also show that governance of cooperatives is an important aspect influencing financial efficiency. Indicators of governance, i.e. annual financial audits compliance and profit tax compliance positively influence financial efficiency, whereas compliance with value-added tax was found to have the opposite effect.

The widespread challenge among cooperatives in SA is not only lack of exposure to appropriate training, but identification of suitable training which allows cooperatives to improve financial efficiency. In the present research, various types of training required to achieve financial efficiency are identified and empirically tested. The results indicate that various kinds of training affect efficiency differently. Therefore, an understanding of relationships between training and financial efficiency by policymakers and practitioners is crucial. Such an understanding allows stakeholders interested in equipping and empowering cooperatives to design and implement suitable training programs. Accordingly, this study illustrates how various types of training affect financial efficiency and, as a result, contributing to a deeper awareness of potential directions for future action in this respect.

This study could help agricultural cooperatives in coming up with strategic decisions necessary for competing in a dynamic market. Underachieving cooperatives could consider learning from their successful peers and then attempt to implement some strategies which lead to attaining

financial efficiency. Another important consideration could be adoption and modification of business plans from market leaders in the sector, that is, either cooperatives of the same or different types or both.

From a policy perspective, the results provided have a role in implementing relevant regulatory mechanisms to direct agricultural cooperatives towards achieving financial efficiency in SA. One main limitation of the current study is the use of cross-sectional data for a one-year period. This dataset fails to account for changes in productivity of the agricultural cooperatives over time. Therefore, future research which focuses on changes in productivity of agricultural cooperatives over a period of time could be a reasonable extension to the present paper.

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