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

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ABSTRACT

Post-1994, the South African government has favoured cooperatives over other types of corporate entities in its rural development programmes. An improved understanding of the key drivers underpinning the performance of cooperatives is important for informing government programmes and policies that target cooperatives. This study examined the financial efficiency, and its determinants, of 387 agricultural cooperatives in South Africa, using the Simar–Wilson methodology. Bias-corrected Data Envelopment Analysis estimates for financial efficiency were obtained in the first stage. The results indicated that many agricultural cooperatives are relatively inefficient, compared to the three best-performing cooperatives on the efficient boundary. In the second stage, a double bootstrap truncated regression model was used to obtain bias-corrected scores that excluded the best-performing cooperatives. The statistically significant efficiency determinants identified from the analysis were the age and size of the cooperative, the gender of the principal manager of the cooperative, its governance and the training indicators. The observed relationship between governance and efficiency may be attributed to institutions that prioritise non-financial goals by being relatively more willing to compromise on governance quality. Furthermore, deviations from sound institutional control mechanisms are more likely to emerge in cooperatives that have weak institutional and organisational arrangements.

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1. Introduction

Cooperatives are often promoted as vehicles for agricultural growth and rural development initiatives in many developing countries (Nganwa et al. 2010). According to Ortmann and King (2005) and Lyne and Collins (2008), such development and growth are achieved when cooperatives facilitate the access of smallholder farmers to input and product markets. The government of South Africa (SA) has placed cooperatives at the forefront to enhance the development of small-scale farmers in rural communities (Ortmann and King 2007a; Chibanda et al. 2009). In this regard, the SA government has dedicated resources and a supportive legal environment for cooperatives by signing a new Cooperatives Act (No.14 of 2005), based on traditional cooperative principles. The new Cooperatives Act seeks to play an essential role among cooperatives by promoting their economic and social development, mainly through the creation of employment, income generation, the facilitation of broad-based Black economic empowerment and poverty eradication (Ortmann and King 2007a; Chibanda et al. 2009).

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The SA government favoured cooperatives over other types of corporate entities in its programmes for rural development. The new Cooperatives Act (No. 14 of 2005) is critical legislation, given that facilitating the use of cooperatives as vehicles for rural development significantly changed the regulatory environment for cooperatives in SA. Since 2005, government programmes have resulted in the registration of many agricultural cooperatives, whereas many of the larger cooperatives that existed pre-2005 were restructured into companies (Ortmann and King 2007a).

Nganwa et al. (2010), among others, criticised the government's decision to regulate the structure of cooperatives along the lines of traditional cooperatives. However, they noted that there was, nonetheless, sufficient flexibility to allow cooperatives to have institutional and organisational arrangements, whereby suitable incentives for successful business enterprises were created. Their concern was that many cooperatives would be structured by using such arrangements, which could result in free-rider problems that would be detrimental to their success. They were also concerned that it would be challenging to restructure failed cooperatives, in order to strengthen their institutional and organisational arrangements.

Because of the increasingly intense competition, globalisation, and technological innovation among institutions (Stewart et al. 2016), researchers, development practitioners and policymakers need to be adequately informed when identifying actual or possible problems that affect agricultural cooperatives. Such information is also essential for comparing the competitiveness and efficiency of agricultural cooperatives. The inefficiency of agricultural cooperatives suggests the existence of opportunities for structural change and increased competition, in order to enhance their efficiency and productivity.

Wijesiri et al. (2015) pointed out that the conventional measures of efficiency include ratio indicators, as well as parametric and non-parametric methods. They added that financial ratios were one of the leading traditional methods used for measuring financial performance. However, measuring efficiency, based on these ratios, is distorted, and it pinpoints the need to adjust the estimates obtained from these indicators. In addition, it is argued that the ratios provide little help for examining the effects of the economies of scale, for the identification of benchmarking policies and the estimation of the overall performance measures of firms. On the other hand, it is better to use frontier methods (i.e., the Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA)) than to use traditional approaches, when measuring the efficiency of institutions.

Ortmann and King (2007a) pointed out that there has been a dearth of research on agricultural cooperatives in SA since 2000. However, Ortmann and King (2007b), Chibanda et al. (2009) and Nganwa et al. (2010) recently conducted studies on agricultural cooperatives in SA. The application of the Simar and Wilson (2007) approach, in particular, has been employed in many studies to measure financial or economic efficiency. This method has recently been applied in research on microfinance institutions (Wijesiri et al. 2015; Wijesiri and Meoli 2015), airports (Barros and Dieke 2008) and banks (Stewart et al. 2016; Fernandes Filipa Da et al. 2018). However, the efficiency analysis has not yet been applied to agricultural cooperatives. Despite the priority given to agricultural cooperatives in SA, as well as the available methods for empirical research, the field remains underresearched. This scarcity of published literature provides an opportunity to further investigate the determinants of the efficiency of these institutions.

Cook (1995), cited in Ortmann and King (2007a), described the agency theory in relation to agricultural cooperatives. Their work provides an insight into the other main components of new institutional economics i.e., the economics of transaction costs and the theory of property rights. Agency relationships arise when an individual or organisation (the principal) assigns another (the agent) to act on their behalf. Problems in the principal-agent relationship arise when an agent fails to act in the principal's best interests, for example, the failure to meet objectives and when the principal fails to put schemes in place that incentivise agents to serve their best interests. The lack of a market for the equity of members in cooperatives disincentivises the members from monitoring the actions of agents. Ortmann and King (2007a) pointed out

that the agency theory is relevant to the institutional structure of cooperatives. According to Cook (1995), Ortmann and King (2007a) and Ortmann and King (2007b) the absence of a clearly-defined financial motive in cooperatives may be one of the reasons why such institutions have more significant principal-agent problems than the proprietary firms have. They added that the agents may not achieve the financial objectives if they focus too much on other objectives, such as the social role of cooperatives.

The objective of this paper is to assess the variability in the financial efficiency of agricultural cooperatives in SA, using the Simar–Wilson methodology. The perennial problem in SA is the large proportion of agricultural cooperatives that have either failed or are inactive (Ortmann and King 2007a), and this could be attributed to their financial inefficiency. Therefore, identifying financial efficiency, and the related constraints, is vital for cooperative development. This study will provide policymakers, particularly in the South African national and provincial departments of agriculture, the extension services, and other advisors, with ways of improving the contribution of cooperatives to development.

2. Literature review on efficiency

No known published studies have confirmed the use of either SFA or DEA for examining the efficiency of agricultural cooperatives in SA. However, these methods had been used to determine the efficiency of microfinance institutions (Wijesiri et al. 2015; Wijesiri and Meoli 2015; Bibi et al. 2018), banks (Stewart et al. 2016; Du et al. 2018; Fernandes Filipa Da et al. 2018) and the transport (airline) industry (Barros and Dieke 2008), amongst others. The studies in which these methods were applied provide an adequate discussion of the theory and application of DEA.

In Mexico, Paxton (2007) used SFA to examine 190 semi-formal institutions in the financial services sector. Determinants, such as technology, the average size of the loans dispersed, the outreach to rural areas and the institutional age were found to be positively linked to technical efficiency. Similarly, Hermes et al. (2011) applied SFA to assess the trade-off between the efficiency of microfinance institutions (MFIs) and the depth of the outreach. Their findings revealed a negative relationship between outreach and efficiency. Servin et al. (2012) used SFA to analyse the technical efficiency of 315 MFIs in 18 Latin American countries. Their results indicated that the type of ownership (e.g., cooperatives and financial institutions) was associated with differences in efficiency.

The application of the DEA approach, followed by a bootstrap procedure, has recently gained popularity in the research of MFIs. For example, between 2009 and 2012, Wijesiri and Meoli (2015) used DEA, based on the Malmquist approach, to investigate the productivity changes across 20 MFIs in Kenya. Their results indicated that the evaluated MFIs experienced an annual average productivity growth of approximately 7%, which was mainly attributable to technological advances. In the second stage of the analysis, the results from the selected independent variables showed that the more recently established MFIs were more likely to have a higher productivity than the older ones.

In Sri Lanka, Wijesiri et al. (2015) used the two-stage double bootstrap approach to investigate the technical efficiency and its determinants. Financial and social DEA models were constructed, and the DEA scores for each model were estimated. The results in the first stage showed that many MFIs in Sri Lanka were not financially and socially efficient. The second-stage results showed that the significant determinants of financial efficiency were age and the ratio of the capital to assets, whereas the age, the type of institution and the return-on-assets influenced social efficiency.

Similarly, Bibi et al. (2018) applied DEA, followed by the double bootstrap truncated regression approach, to investigate the efficiency of MFIs in South Asia. In their application of the Simar and Wilson (2007) approach, the first-stage analysis results showed that the MFIs were generally more financially efficient than socially efficient. The main factor that was identified as positively influencing

the efficiency of MFIs was the gender of the employees. Both financial and social efficiencies were strongly associated with good governance.

The Simar and Wilson (2007) approach was also used to investigate efficiency in the banking sector. Between 2007 and 2014, Fernandes Filipa Da et al. (2018) evaluated the efficiency of banks in Europe. Their DEA model used the Malmquist Productivity Index (MPI) to estimate the bank efficiency scores. The results of their study of peripheral European domestic banks revealed the significant determinants of efficiency (i.e., liquidity and credit risk) that were negatively associated with productivity. On the other hand, factors such as capital and profit risk positively influenced productivity.

Du et al. (2018) provided an example of the application of the Simar and Wilson (2007) approach to panel data. Their study investigated the determinants of the efficiency of Chinese banking institutions between 2006 and 2011. The results showed that a bank's efficiency was positively associated with its assets. A decrease in the non-earning assets and an increase in total equity were positively associated with bank efficiency.

Stewart et al. (2016) analysed the efficiency of banks in Vietnam between 1999 and 2009. The results suggested that larger banks were more efficient than smaller ones. The type of financial institution i.e., whether they were state-owned commercial banks, or otherwise, had an impact on efficiency. For example, state-owned commercial banks were found to be less efficient than their counterparts. The study also revealed that older institutions were less efficient, compared to those that were younger. In addition, banking institutions with more extensive branch networks led to lower efficiency levels.

From the brief literature review of studies that applied the Simar and Wilson (2007) approach, the significant determinants influencing efficiency were identified (Bibi et al. 2018; Du et al. 2018). These include the age of an institution and its size, the type of institution, the gender of the employees, the institutional governance indicators and the credit risk. The review highlighted various proxies for the institutional size that were used across these studies, including equity, liquidity, asset value, return to assets and profits.

3. Methodology

3.1. Data

Data from the 2017-period of the Co-operative Data Analysis System (CODAS) were accessed for 387 agricultural cooperatives. These cooperatives were selected from a database of 3,197 cases. Cases with missing observations were omitted from the analysis. Permission to access the online data was obtained from the Directorate of Cooperatives and Enterprise Development. Data were captured in the Microsoft Excel format and then loaded into the Statistical Package for the Social Sciences (SPSS) and the Stata software for analysis.

3.2. Selection of input and output variables

The use of deterministic DEA approaches was criticised in previous empirical studies because of their shortcomings. The two-stage double bootstrap method was recommended as a preferable method. In this study, the latter approach was adopted, following Wijesiri and Meoli (2015), Wijesiri et al. (2015), Stewart et al. (2016) and Bibi et al. (2018). The estimator of the DEA efficiency was corrected for bias in the first stage of the analysis by using the homogeneous bootstrap procedure (Simar and Wilson 2000). In the second stage of the analysis, the bias-corrected efficiency scores were regressed on a set of independent variables by applying the truncated regression with the bootstrap approach (Simar and Wilson 2007). Simar and Wilson (2007) stated that the efficiency scores estimated in the first stage are not independent observations, because estimating the efficiency of one Decision-Making Unit includes all the other Decision-Making Units (DMUs) in the sample. As a result, the

error term in the second-stage regression is serially correlated and produces inconsistent and biased estimates. For this reason, Simar and Wilson (2007) criticised some of the most widely-used techniques, such as the censored regression models in a second-stage analysis (e.g., the Tobit model). According to Simar and Wilson (2007), the bootstrap approach provides meaningful conclusions, as the method corrects the bias and serial correlations of efficiency estimates, thus providing valid inferences.

The consensus in literature suggests that, by using DEA to estimate financial efficiency, the labour (Wijesiri et al. 2015; Wijesiri and Meoli 2015; Stewart et al. 2016; Bibi et al. 2018) and operating expenses (Wijesiri and Meoli 2015; Bibi et al. 2018; Fernandes Filipa Da et al. 2018) are two of the key input variables to consider among others. In addition, Bibi et al. (2018), Wijesiri and Meoli (2015) and Wijesiri et al. (2015) considered estimating the financial efficiency in the first stage of DEA. For the estimation procedure in this study, two inputs were used i.e., the Constant Returns to Scale (CRS) was used to fit the DEA model – and, more precisely, the CRS-input-oriented DEA efficiency results were estimated. The CRS model in DEA assumes that all input/output data are known and that the production of the outputs is perfect and complete. The efficiency score ranges from zero to one, where the DMUs that are assigned a score of one are considered to be relatively efficient, while those receiving a score of zero are relatively inefficient.

Benchmarking the agricultural cooperatives in the study against a specific reference of interest helps to understand the relative efficiency of these cooperatives. The reference of interest, in this case, is the operational level at which the highest output per input is obtained. According to Du et al. (2018), the CRS form of the DEA benchmarks all agricultural cooperatives, as far as the observed optimal level of operation is concerned, by estimating the smallest best-practice convex frontier that fits the observed data. This is the main reason why the CRS form was selected for this study. In addition, the benefits of using CRS-DEA include a faster statistical convergence rate and a higher discriminatory power. Table 1 shows the indicators of these input and output variables and how they are defined.

The explanatory variables used in the second stage are presented in Table 2, which shows the expected signs of these variables and their hypothesised effects on efficiency. Institution-specific variables, such as the age, size and type of the institution, were selected in the second stage. According to Wijesiri et al. (2015), the age of an institution is a proxy for its experience and managerial ability. Wijesiri and Meoli (2015) and Bibi et al. (2018) found a positive relationship between the age of an entity and its financial efficiency, whereas Stewart et al. (2016) observed a negative relationship in this regard. In this study, the age of the cooperatives is expected to be positive. At some point, this positive relationship is anticipated to change from positive to negative. This is captured by the square of the age of the cooperative and is expected to be negative. The square of a positive effect of age and a negative effect of the square of the age confirms that the effect of age is lessened as an institution gets older; therefore, the age of an institution is expected to have a reduced effect among older agricultural cooperatives.

The Principal Component Analysis (PCA) was conducted on the observable membership and cooperative size measures, and the PCA results for these variables can be found in Appendices 1–4. The main reason for using the PCA was to reduce the number of variates used in the regression analysis, to reduce the dimensions existing in these respective measures and to remedy the problem of multicollinearity (Jolliffe 2002). PCA is a data reduction technique that is often used to

Table 1. Input and output variables used in the first-stage DEA model for assessing 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

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

Variable definition	Expected sign
Operating years of the cooperative since registration (AGE)	+
Square of operating years of the cooperative (AGE_SQ)	−
Number of animals in piggery production (PIGGERY)	+/−
Number of animals in poultry production (POULTRY)	+/−
Cooperatives' membership group size (GRP_SIZE)[a]	+
Cooperatives' full-time employees (FULL_TIME)[a]	+
Cooperatives' male committee chairpersons and male managers (MALE_MGR)[a]	+
Cooperatives' registered members with a disability and attend general meetings (DISABILITY)[a]	+
Cooperatives' part-time employees (PART_TIME)[a]	+
Youth in management committees, in part-time employment, and as chairpersons (YTH_COMM)[a]	−
Youth managers (YTH_MGR)[a]	+
Employed members with a disability and female members in management committees (DISEMPL_FEM)[a]	+
Cooperatives' size of operations (SIZE_OPS)[a]	−
Cooperatives' size of borrowings (SIZE_BORR)[a]	−
Compliance with annual financial audits (FINAUD_COMPL)[b]	+
Value added tax compliance (VAT_COMPL)[b]	+
Profit tax compliance (PROFIT_COMPL)[b]	+
Cooperative principles compliance (COOPPRINC_COMPL)[b]	+
Accounting and bookkeeping compliance (ACCBK_COMPL)[b]	+
Cooperative principles training (COOPPRINC_TRAIN)[c]	+
Farm together Training Programme (FARMCOOP_TRAIN)[c, d]	+
Cooperative finance training (COOPFIN_TRAIN)[c]	+
Cropping, farming, and vegetable production training (CRVEG_TRAIN)[c]	+
Farming management training (FARMMGT_TRAIN)[c]	+
Project management training (PROJMGT_TRAIN)[c]	+
Control mechanisms training (CONTMECH_TRAIN)[c]	+
Entrepreneurship training (ENTREP_TRAIN)[c]	+
Equipment repairs and maintenance (EQPTRM_TRAIN)[c]	+

Note: + is positive, − is negative; [a]PCA index; [b]dummy variable that is equal to 1 if the cooperative complies; and 0 if otherwise; [c]dummy variable that is equal to 1 if the cooperative has received this kind of training and 0 if otherwise [d]According to the Department of Agriculture, Forestry and Fisheries, DAFF (2012), Farm together Training Programme is a learning initiative whose main focus is supporting agricultural cooperatives by addressing a range of skills (e.g., governance, business skills, and business choices).

investigate the relationship between variables. Thus, PCA takes $X_1, X_2, \ldots, X_p$ and computes the linear combinations of these variables, representing the p dimensions or PCs (i.e., $PC_1, PC_2 \ldots, PC_n$, where $n \leq p-1$) that each contains all p Xs and are uncorrelated. The following equation shows the linear combinations of all p original variables, $X_1, X_2, \ldots, X_p$:

$$PC_1 = a_{11}X_1 + a_{12}X_2 + a_{13}X_3 + \ldots a_{1p}X_p \quad (1)$$

where $a_{11}, a_{12}, a_{13}, \ldots, a_{1p}$ are the component loadings that are estimated so that the first eigenvector captures as much variance in the original variables as possible, subject to the condition that:

$$a_{11}^2 + a_{12}^2 + a_{13}^2 + \ldots a_{1p}^2 = 1 \quad (2)$$

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

The theoretical and empirical evidence suggests that larger institutions, in terms of assets, reduce the costs associated with the gathering and processing of information. Stewart et al. (2016), Bibi et al. (2018) and Fernandes Filipa Da et al. (2018) presented arguments for a positive relationship between the institution-specific variable and the financial efficiency. In the present study, indicators for the operating expenses (SIZE_OPS) and borrowings (SIZE_BORR) of the cooperatives, instead of its assets, were used as a measure of size. Hence, the relationship between these indicators of size and financial efficiency is expected to be negative. The other institution-specific variables, namely the type of institution, are expected to have either a positive or negative effect on financial

efficiency. Wijesiri and Meoli (2015) used a similar type of institution as a determinant of financial efficiency.

Bibi et al. (2018) posited that the leadership of an institution provides suitable proxies for measuring governance. The governance indicators used in the present study are compliant with the annual financial audits (FINAUD_COMPL), cooperative principles (COOPPRINC_COMPL), value-added tax (VAT_COMPL), profit tax (PROFIT_COMPL) and accounting and bookkeeping compliance (ACCBK_COMPL). These indicators are all hypothesized to have a positive relationship to the financial efficiency. For example, accounting and bookkeeping compliance is expected to increase the financial efficiency because of this expected sign of the coefficient of the variable. The expected sign implies that a cooperative should comply with accounting and bookkeeping standards in order to become more financially efficient. The same reasoning is applied to the rest of the governance indicators mentioned above. Some PCA variables that capture the characteristics of the cooperative committee were also selected as indicators for governance. One of the PCA variables measured a cooperatives' dimensions of youth in management committees (YTH_COMM) and another part-time employment and as chairpersons (PART_TIME). Bibi et al. (2018) found a negative relationship between financial efficiency and female-headed committees, and that it is counter-intuitive to reason that male-headed committees will also lead to a lower financial efficiency. Therefore, the PCA variable representing male committee chairpersons and managers (MALE_MGR) is hypothesized to increase the financial efficiency.

Indicators for the agency and group size were also considered. Agency indicators were PCA indices, the first representing the cooperatives' dimension of youth managers (YTH_MGR) and the second representing the cooperatives' dimension of employed members living with a disability and female members on the management committees (DISEMPL_FEM). These agency indicators were both hypothesised to affect the measure of financial efficiency positively. The group size indicator, GRP_SIZE, also a PCA index, was hypothesised to relate positively to the financial efficiency. The group size was also measured by the PCA index that captured variables for members with a disability, who attended general meetings and who were registered as DISABILITY. These were hypothesised to influence the measure of financial efficiency positively.

Employment indicators were also considered as indicators that affect the measure of financial efficiency. These were for the PCA dimensions of full-time (FULL_TIME) and part-time employment (PART_TIME), and the employment of people with disabilities (DISEMPL_FEM). The *a priori* expectation was that these variables would positively relate to the dependent variable, suggesting that the increasing employment in these dimensions was expected to increase the financial efficiency. The last set of indicators that refer to training are also presented in Table 2. All the training variables were hypothesised to be positively related to the measure of financial efficiency. It is therefore expected that a cooperative should be involved in the training of its members in order to become more financially efficient.

4. Results

Table 3 presents the summarised statistics of all the variables used in the first- and second-stage models. These findings indicate that the operating expenditure of cooperatives in SA is double the value of its wage bill. In addition, the average turnover for the cooperatives sufficiently covers the total expenses. The value of the DEA score for financial efficiency is 0.167, implying a relatively low level for this measure. Overall, these results show that, although cooperatives in SA can cover their operating expenses, on average, most of them have a relatively low financial efficiency.

Table 3 further provides the summary statistics for variables used in the second-stage analysis. In this stage, variations are observed; for instance, the average age of the cooperatives is under nine years, which may imply relatively young entities. On the other hand, the standard deviation for the age of cooperatives is 14, which suggests the presence of older cooperatives in the agricultural sector.

Table 3. Descriptive statistics for efficiency evaluation using DEA ($n = 387$).

Definition	Mean	Std Dev
First stage DEA model input variables		
Annual wage expenses (in thousand Rands)	86.00	615.00
Annual operating expenditure (in thousand Rands)	172.00	650.00
First stage DEA model output variable		
Annual turnover (in thousand Rands)	334.00	2037.00
Financial efficiency score from DEA (theta)	0.1670	0.1513
Second stage explanatory variables		
Operating years of the cooperative since registration	9	14
Square of operating years of the cooperative	295	1726
Number of animals in piggery production	60	1068
Number of animals in poultry production	1032	8323
Group size[a]	0.00313	1.0271
Full time employees[a]	−0.0208	0.9121
Male managers[a]	−0.0074	1.0091
Disability[a]	−0.0033	1.0201
Part-time employees[a]	−0.0083	1.0000
Youth management committee[a]	0.0133	1.0144
Youth managers[a]	−0.0026	1.0256
Disability employment and female managers[a]	−0.0148	0.9888
Cooperative size operations[b]	0.000000026	1.0000
Cooperative size borrowings[b]	0.000000025	1.0000
Annual financial audit[c]	0.3514	0.4780
Value added tax compliance [c]	0.3152	0.4652
Profit tax compliance[c]	0.4238	0.4948
Cooperative principles[c]	0.7442	0.4369
Accounting and bookkeeping[c]	0.5995	0.4906
Cooperative principles training[c]	0.0336	0.1804
Farm together Training Programme[c]	0.1395	0.3470
Cooperative finance training[c]	0.0258	0.1589
Cropping, farming, and vegetable production training[c]	0.0646	0.2461
Farming management training[c]	0.0026	0.0508
Project management training[c]	0.0078	0.0878
Control mechanisms training[c]	0.0388	0.1933
Entrepreneurship training[c]	0.0026	0.0508
Equipment repairs and maintenance training[c]	0.0052	0.0718

Note: Obs. is the number of observations; Std Dev is standard deviation; [a]PCA index (see Equations (3)–(10)); [b]PCA index (see Equations (11)–(12)); [c]dummy variable.

The descriptive statistics for the variables used to determine the PC membership dimensions of the cooperatives are presented in Table 4.

In Table 4, the data on agricultural cooperatives show that, on average, representation is higher for female variables, such as registered female members (FEMREG), active female members (ACTFEM), female members who attended the recent AGM (FEMAGM) and female members on management committees (FEMMCOM), among others, than for the corresponding male variables. However, female representation in management is less, as seen in the variable female manager (FEMMGR), than for males in management positions.

The PCs were extracted from the correlation matrix computed for the variables in Table 4. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and the Bartlett's test of sphericity were used to determine whether the dataset of the cooperatives could be factored. The KMO measure was 0.753, 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 with a statistically significant value for the Bartlett's test (i.e., $p < 0.05$) indicated that the respective variables can be factored. Eight PCs had an eigenvalue of larger than one, and they accounted for 81.33% of the variation in the data, following Jolliffe (2002). Varimax, together with the Kaiser Normalization rotation method, were used to improve the interpretation of the PCs. Therefore, these PCs were considered to be suitable indices to represent dimensionality in the membership of cooperatives. Each of the components was a linear combination of the membership indices. The names of variables appearing

Table 4. Variables used to compute PC membership dimensions ($n = 387$).

Variables	Mean	Std. Dev.
Registered male members (MALEREG)	13	66
Registered female members (FEMREG)	17	93
Registered youth members (REGYTH)	4	27
Registered disabled members (DISREG)	1	2
Active male members (ACTMALE)	11	61
Active female members (ACTFEM)	15	84
Active youth members (ACTYTH)	4	27
Male members attended the recent AGM (MALEAGM)	10	31
Female members attended the recent AGM (FEAGM)	13	82
Male members attended the previous AGM (MAPRAGM)	7	60
Female members attended previous year's AGM (FEPRAGM)	13	83
Youth members attended previous year's AGM (YTHAGM)	4	26
Disabled members attended previous year's AGM (DISAGM)	1	2
Male members in management committee (MALEMCOMM)	3	3
Female members in management committee (FEMCOM)	4	3
Youth members in management committee (YTHMGTCOM)	1	2
Male committee chairperson (MALECOMCHR)	1	1
Female committee chairperson (FEMCOMCHR)	1	1
Youth committee chairperson (YTHCOMCHR)	0	1
Male manager (MALEMGR)	1	1
Female manager (FEMMGR)	0	1
Youth manager (YTHMGR)	0	0
Male full-time employees (MALEFT)	3	16
Female full-time employees (FEMFT)	3	12
Youth full-time employees (YTHFT)	1	4
Disabled full time employees (DISFT)	0	1
Male part time employees (MALEPT)	2	4
Female part time employees (FEMPT)	2	8
Youth part-time employees (YTHPT)	0	1

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

on the right-hand side of the equations below are described in Table 3. The first PC accounted for the most significant variation of 37.78% in the total variance, and signs for all the coefficients were positive. This PC showed the composition of active group membership, membership participation, registration, as well as group size, and was named "Group size" (GRP_SIZE). This suggests that aspects of the group size expressed in the equation moved very closely together and, therefore, that the component measured the variation in the series that occurred when these 11 characteristics of membership were moving in the same direction.

$$\begin{aligned} \text{GRP\_SIZE} = {} & 0.989(\text{FEMAGM}) + 0.983(\text{MALEAGM}) + 0.980(\text{ACTFEM}) + \\ & 0.980(\text{ACTYTH}) + 0.978(\text{YTHREG}) + 0.977(\text{YTHPRAGM}) + 0.962(\text{MALEAGM}) + \\ & 0.962(\text{MALEPRAGM}) + 0.960(\text{ACTMALE}) + 0.931(\text{FEMREG}) + \\ & 0.917(\text{MALEREG}) \end{aligned} \tag{3}$$

The second PC accounted for 10.17% of the variation in the data and represented the gender composition of full-time, as well as youth, employment. In this PC, the variable for women in full-time employment was dominant, therefore the PC was called "Women in full-time employment" (FTEMPLOYEES_1). The linear combinations of this PC are shown below. The signs of the variables were all positive, which suggests that indicators for full-time employment generally move very closely together. For instance, a cooperative with a high number of female full-time employees have a high number of total full-time employees, including males and youth.

$$\text{FTEMPLOYEES\_1} = 0.967(\text{FEMFT}) + 0.940(\text{MALEFT}) + 0.914(\text{YTHFT}) \tag{4}$$

The third component was named "Male management" (MALEMGT_1) because it represented male cooperative members in management and committee chairperson positions. The composition of this

PC was as follows:

$$\begin{aligned}\text{MALEMGT\_1} = &-0.877(\text{FEMCOMCHR}) + 0.834(\text{MALECOMCHR}) + 0.653(\text{MALEMGR}) \\ &-0.653(\text{FEMMGR})\end{aligned} \tag{5}$$

It accounted for 8.49% of the rotated summed variation. This linear combination in the principal component implies that a common positive association exists amongst male managers and the committee chair, including the number of low female committee chairpersons and female managers.

The fourth component describes the bond between the cooperative members who live with disabilities, are registered, and attend annual general meetings. Because of this composition, the PC was called "Cooperative members living with disabilities" (DISABILITY_1). This PC explained 6.46% of the variation in the membership indices.

$$\text{DISABILITY\_1} = 0.947(\text{DISPRAGM}) + 0.939(\text{DISREG}) \tag{6}$$

The next PC points to a linear relationship among the male, female and youth part-time employees, and the male committee members. Because of this composition of agricultural cooperative members in part-time employment, this PC was called "Part-time employment" (DISABILITY_1). This PC accounted for 6.09% of the variation.

$$\text{PTEMPLOYEES\_1} = 0.837(\text{MALEPT}) + 0.756(\text{FEMPT}) + 0.507(\text{MALEMCOM}) + 0.416(\text{YTHPT}) \tag{7}$$

The sixth PC accounted for 4.82% of the variation and represented the youth composition in management committees, as chairpersons and in part-time employment. It was, therefore, named "Youth in management committees" (YTHMGTCOMM_1) to describe the dimension that captured the attributes described above. The linear combinations of this PC suggested the existence of a common positive association amongst the youth factors for the management committee, chairmanship and part-time employment.

$$\text{YTHMGTCOMM\_1} = 0.738(\text{YTHMCOM}) + 0.622(\text{YTHCOMCHR}) + 0.459(\text{YTHPT}) \tag{8}$$

The dimension represented by the seventh component was dominated by the involvement of the youth in management committees and management. This PC was named "Youth management" (YTHMGT_1) and the relationship of these variables is shown below:

$$\text{YTHMGT\_1} = 0.484(\text{YTHCOMCHR}) + 0.887(\text{YTHMGR}) \tag{9}$$

It explained 4.07% of the total variation. This PC captured the variance that was caused when youth committee chairs and youth managers were positive and moved in the same direction.

The eighth PC accounted for 3.45% of the variation and measured the variance that occurred when disabled full-time employees and female committee members moved in the same direction. This PC was named "Full-time disabled employees" (DISEMPFEMMGT_1).

$$\text{DISEMPFEMMGT\_1} = 0.687(\text{DISFT}) + 0.580(\text{FEMMCOM}) \tag{10}$$

Descriptive statistics for variables used to construct the principal components for cooperative size are presented in Table 5.

Table 5. Variables used to compute cooperative size dimensions (Rands in thousands ('000) per annum for the previous year) ($n = 387$).

Variable	Mean	Standard Deviation
Expenditure (EXPENYR)	172.00	650.00
Turnover (TURNYR)	334.00	2,037.00
Annual wages (WAGEYR)	86.00	615.00
Total owed to creditors (OWEDYR)	6.00	46.00
Outstanding Loans (banks) (LOANYR)	8.00	58.00

The PCs for the cooperative size were also extracted from the correlation matrix of variables presented in Table 5. The KMO measure and the Bartlett's test of sphericity, as described earlier, were also used in this instance. The use of Varimax with the Kaiser Normalization rotation was also included. The KMO measure was 0.532 and the Bartlett's test was statistically significant at $p<0.001$. Two dimensions of the cooperative size were extracted, and both accounted for 71.80% of the variation in the cooperative size indices. These indices had an eigenvalue of greater than one. The first PC in Table 5 described the relationship between the turnover, expenditure and annual wages of the agricultural cooperative in the previous year, and it was therefore named "Size of operations" (SIZE_OPS). This component explained 40.77% of the variation in cooperative size indices.

$$\text{SIZE\_OPS} = 0.877(\text{TURNYR}) + 0.855(\text{EXPENYR}) + 0.721(\text{WAGEYR}) \quad (11)$$

The second component points to a linear relationship between the total money owed to creditors and the outstanding loans to financial institutions, and it indicates the size of borrowing of the agricultural cooperative. Therefore, the PC was named "Size of borrowings" (SIZE_BORR).

$$\text{SIZE\_BORR} = 0.889(\text{OWEDYR}) + 0.804(\text{LOANYR}) \quad (12)$$

The Simar and Wilson regression model predicting the estimates for financial efficiency was statistically significant (Chi-square (27) = 69.56, $p < 0.001$) (Table 6). In estimating the empirical model

Table 6. Simar and Wilson regression estimates for financial efficiency.

Financial efficiency	Coefficients	Bootsrap Std. Err.
Operating years of the cooperative since registration (AGE)	0.0140***	0.0044
Square of operating years of the cooperative (AGE_SQ)	−0.0001***	0.0000
Number of animals in piggery production (PIGGERY)	−0.0000	0.0000
Number of animals in poultry production (POULTRY)	−2.916e-08	2.52e-06
Group size (GRP_SIZE)[a]	0.0016	0.0174
Full-time employees (FULL_TIME)[a]	0.0114	0.0226
Male managers (MALE_MGR)[a]	0.0382**	0.0186
Disability (DISABILITY)[b]	0.0136	0.0190
Part-time employees (PART_TIME)[a]	−0.00512	0.0263
Youth management committee (YTH_COMM) [a]	−0.0199	0.0180
Youth managers (YTH_MGR)[a]	0.0203	0.0204
Disability employment and female managers (DISEMPL_FEM)[a]	0.0236	0.0166
Cooperative size of operations (SIZE_OPS)[b]	−0.0857***	0.0255
Cooperative size of borrowings (SIZE_BORR)[b]	−0.0358	0.0230
Annual financial audit compliance (FINAUD_COMPL)[c]	0.1823***	0.0588
Value added tax compliance (VAT_COMPL)[c]	−0.1392***	0.0516
Profit tax compliance (PROFIT_COMPL)[c]	0.0755*	0.0484
Cooperative principles compliance (COOPPRINC_COMPL)[c]	−0.0217	0.0478
Accounting and bookkeeping compliance (ACCBK_COMPL)[c]	−0.0866*	0.0515
Cooperative principles training (COOPPRINC_TRAIN)[c]	0.1255	0.2239
Farm together Training Programme (FARMCOOP_TRAIN)[c]	0.1077**	0.0538
Cooperative finance training (COOPFIN_TRAIN)[c]	0.4713	0.3365
Cropping, farming, and vegetable production training (CRVEG_TRAIN)[c]	−0.107	0.0879
Farming management training (FARMMGT_TRAIN)[c]	−0.7228*	0.3718
Project management training (PROJMGT_TRAIN)[c]	−0.5720**	0.2788
Control mechanisms training (CONTMECH_TRAIN)[c]	−0.3259	0.2608
Entrepreneurship training (ENTREP_TRAIN)[c]	0.3748	0.3597
Equipment repairs and maintenance training (EQPTRM_TRAIN)[c]	0.5241*	0.3055
_cons	−0.1538**	0.0732
Sigma	0.2180***	0.2020
Number of observations = 384		
Number of efficient DMUs = 3		
Number of bootstrap. reps = 1000		
Wald Chi^2 (27) = 69.56		
Prob > Chi^2 (26) = 0.0000		

Note: *p*-values in parentheses; *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$; [a]PCA index (see Equations (3)–(10)); [b]PCA index (see Equations (11)–(12)); [c]dummy variable.

above, two important observations were made. Firstly, 387 cases were used in the estimation, i.e., three efficient DMUs were compared to 384 inefficient cases. Secondly, Table 6 reports 387 cases after omitting the missing values on some of the variables in Table 5. The variable for the operating years of the cooperative since registration (AGE) was statistically significant at $p < 0.001$. A unit increase in this variable resulted in a 0.014 increase in the predicted financial efficiency score. The square of the cooperative's operating years (AGE_SQ) was also statistically significant at $p < 0.001$, and it was negatively related to the financial efficiency score. The measure for the cooperative size, namely, the size of operations (SIZE_OPS), was statistically significant at the 1% level and related negatively to the financial efficiency. One of the indicator variables that represented the cooperatives' PCA dimension of male committee chairpersons and male managers (MALE_MGR) was also statistically significant and positive at $p < 0.10$. Variables for compliance with annual financial audits (FINAUD_COMPL) and value-added tax (VAT_COMPL) were statistically significant at the 1% level. Accounting and bookkeeping compliance (ACCBK_COMPL) and profit tax compliance (PROFIT_COMPL) were found to be statistically significant at the 10% level. Compliance with the annual financial audits (FINAUD_COMPL) was positively related to the financial efficiency score. Therefore, the annual financial audit procedures (FINAUD_COMPL) and profit tax (PROFIT_COMPL) compliance increased the financial efficiency score by 0.182 and 0.078, respectively. Accounting and bookkeeping (ACCBK_COMPL) and value-added tax (VAT_COMPL) compliance led to a 0.0866 and 0.139 decrease, respectively, in the financial efficiency score. Variables for training that were statistically significant and that positively affected the score for financial efficiency were the Farm Together Training Programme (FARMCOOP_TRAIN), and equipment repairs and maintenance (EQPTRM_TRAIN) at the 5% and 10% levels, respectively. Training variables that negatively affected the financial efficiency score were farming management (FARMMGT_TRAIN) and project management (PROJMGT_TRAIN), at a 10% and 5% level of statistical significance, respectively.

5. Discussion of results

The results in the first-stage analysis showed that a large proportion of agricultural cooperatives in SA are financially inefficient in relation to those on the efficient frontier. 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 to be bad. Likewise, the absence of highly-efficient cases can make other units appear to be more efficient than they really are. Several control variables reveal a relationship between efficiency, on the one hand, and the age, size and type of the institution, the gender of the management, as well as the institution's governance and training variables, on the other. This study is generally in line with the findings of the previous studies. The age of agricultural cooperatives (AGE) positively influence the measure of financial efficiency. Wijesiri et al. (2015) and Bibi et al. (2018) found similar results, while Stewart et al. (2016) found age to be negatively linked to financial efficiency. Wijesiri et al. (2015) explained that many entities find it difficult to break even at the onset of their operations, but that they improve with time. Therefore, older agricultural cooperatives tend to be more financially efficient than those that are younger. Wijesiri et al. (2015) stated that age is a suitable proxy for managerial ability, thereby implying that older agricultural cooperatives perform better. They added that entities would possess a relatively high-efficiency measure if they improved their management practices. Intuitively, having a better managerial ability in agricultural cooperatives leads to higher relative financial efficiency. 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 cooperatives (AGE_SQ). This means that the effect of age on the financial efficiency indicator lessens, as institutions get older.

In terms of asset size, larger institutions reduce the costs associated with the gathering and processing of information. In this study, the operating costs were adapted to the proxy asset size, as in the research of Stewart et al. (2016), Bibi et al. (2018) and Fernandes Filipa Da et al. (2018). According

to the results, relatively lower operating costs (SIZE_OPS) lead to a higher measure of financial efficiency for agricultural cooperatives.

The influence of governance indicators on the financial efficiency measure revealed mixed results. Compliance with annual financial audits (FINAUD_COMPL) and profit tax (PROFIT_COMPL) appear to have a positive and statistically significant influence on financial efficiency. This is consistent with the findings of Bibi et al. (2018) and Müller and Uhde (2013). On the contrary, value-added tax (VAT_COMPL) and accounting and bookkeeping compliance (ACCBK_COMPL) were negatively related to the financial efficiency indicator. Indicators that negatively influence financial efficiency arguably represent weak governance (Barry and Tacneng 2014). More specifically, Barry and Tacneng (2014) made a strong case for weak governance, showing that financial institutions tend to relax some of the rules and procedures, which 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 the financial efficiency objectives (Wijesiri and Meoli 2015; Bibi et al. 2018). Barry and Tacneng (2014) observed financial institutions that leaned towards compromising governance quality, probably to prioritise the social objectives over the financial goals. The reason for the low efficiencies that were measured (16%) could be because the financial performance was not the primary focus of the agricultural cooperatives. Therefore, the observed negative relationship between governance indicators and the financial efficiency of agricultural cooperatives may suggest that cooperatives are inclined to relax some of their internal controls to accommodate for other non-financial objectives. Boehe and Barin Cruz (2013) and Barry and Tacneng (2014) emphasised the important effect of the institutional environment on the incentives and behaviour of both the institutions and the affiliates of those institutions. They mentioned that a deviation from the 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 environment. The Cooperatives Act (No.14 of 2005) has been criticised for not being fully capable of transforming the cooperative sector in SA because of the problems created by the same Act. For example, one of the problems with this model was that the adoption of the Act was a precondition for receiving government support (Nganwa et al. 2010). Intuitively, some internal controls of cooperatives may have been established, based on the expectation that they would receive some form of government support. Where this kind of support is not forthcoming, it may create a situation where several registered agricultural cooperatives, according to this legal framework, are not benefiting from the expected assistance. In other words, cooperatives will be established that are involved in informal activities. The possible reason for the involvement of cooperatives in informal activities may be for their economic survival. According to Quintin (2008), a weak rule of the law indicates a large economy that is dominated by informal activities, and a group consensus in institutions seeking to achieve financial gain may prevent them from taking advantage of marginal opportunities, or may encourage them to take on board members that are on-board members who are financially inadequate. Nganwa et al. (2010) pointed out that some agricultural cooperatives shed off their poorest members and create their own rules to reward the remaining members. This is in line with the view of Barry and Tacneng (2014), who ascertained that shareholder-owned institutions tend to benefit from good quality governance practices. In such cases, the rule of law appears to be strong, while the relation-based exchanges are less critical.

The results of the present research indicate that male management (MALE_MGR) positively affects efficiency. According to King and Mason (2001), women in developing countries are often confined to specific occupations and are largely excluded from taking up managerial positions in the formal sector. This limitation and exclusion also seem evident for women in managerial roles of agricultural cooperatives in SA, in that the average number of females in management is less than that of males (Table 4). In part, this may be the reason why the dimension of male management (MALE_MGR) influences financial efficiency, and also why the indicator for female management (DISEMPL_FEM) in this study was found to have no significant impact on the measure of efficiency. However, it has been suggested that the involvement of women in management and executive designations, such as

becoming board members, leads to an improvement in organisational performance (Strøm et al. 2014). For instance, Bibi et al. (2018) found that female management has a positive impact on financial efficiency. Although the indicator for female management (DISEMPL_FEM) was found to have no significant impact on efficiency, as mentioned earlier, the findings of Strøm et al. (2014) and Bibi et al. (2018) indicated the contrary. It is most likely that proxies for gender, i.e., male management (MALE_MGR) and female management (DISEMPL_FEM), capture the effects that reveal gender bias. Rural women in most developing countries are considered to be more disadvantaged than their male counterparts because of the gender bias arising from limited access to resources, socio-cultural inhibitions and alternative demands on their time, such as childcare and other domestic duties (King and Mason 2001). The estimated equation for this PC, as shown in Equation (5), further supports the view of gender bias. The representation of males in management and committee chairpersons is positive, while that of females is negative. In previous studies, such as Pletzer et al. (2015), the increasing female representation on the boards of firms seemed not to have influenced their financial performance. Their study advocated that increasing female representation should not matter, since doing so does not influence financial performance, either positively or negatively. In the case of South African agricultural cooperatives, the promotion of gender diversity, or increasing the female representation in management roles and committee chairpersons, has led to a reduction in financial efficiency. Increasing female representation in the designations under discussion promotes other goals, such as the social orientation of organisations, without having a detrimental effect on the financial performance (Périlleux and Szafarz 2015).

Wößmann (2008) posited that the efficiency of education training systems can be improved by reforms that are oriented towards output productivity. In addition, these reforms perform optimally in a well-regulated environment that is geared towards accountability. The measure of financial efficiency used in the present study, as well in the studies by Wijesiri et al. (2015), Stewart et al. (2016) and Fernandes Filipa Da et al. (2018), provide a representation of the measure of productivity. Therefore, the same argument can be applied to agricultural cooperatives in the sense that institutions receiving such training may improve their productivity and/or their financial efficiency. Dearden et al. (2006) identified work-related training as one of the critical factors that is responsible for increasing productivity. Training in areas, such as the use of equipment, repairs and maintenance (EQPTRM_TRAIN), positively influences financial efficiency. In addition, cooperative finance training (COOPFIN_TRAIN) and training received from the government programme, Farm Together Training (FARMMGT_TRAIN), have a positive impact on efficiency. Training variables that negatively affected the financial efficiency score were farming management (FARMMGT_TRAIN) and project management (PROJMGT_TRAIN) training at a 10% and 5% level of significance, respectively. It is important to highlight that the training variables in this study do not indicate specifically who of the cooperative members, employees, committee members or managers receive the training.

6. Conclusion

This study examined financial efficiency and its determinants among 387 agricultural cooperatives in SA. A DEA model was constructed to capture the financial efficiency scores of these cooperatives. In this research, the Simar and Wilson (2007) approach was adopted to obtain the financial efficiency measure of the agricultural cooperatives. The first-stage results revealed that a high number of cooperatives are relatively financially inefficient. In the second stage, the regression results showed that older cooperatives are more financially efficient, compared to younger organisations. These results showed that cooperatives find it challenging to break even in their early stages and that they perform better over time, when they increase in size and improve their management processes. The results suggested further that cooperatives become financially efficient as their size increases. The second-stage regression results also showed that the governance of cooperatives is essential in influencing their financial efficiency. The indicators of governance i.e., annual financial audit

compliance and profit tax compliance positively influenced the financial efficiency, whereas compliance with the value-added tax had the opposite effect.

The study revealed several widespread challenges that affected the financial efficiency of cooperatives, including those related to training and governance indicators. Cooperatives in SA not only lack exposure to appropriate training, but they also lack the ability to identify suitable training that will allow them to improve their financial efficiency. The results indicated that various kinds of training affect efficiency differently. Therefore, policymakers and practitioners must understand the relationship between training and financial efficiency. Such an understanding allows stakeholders who are interested in equipping and empowering cooperatives, to design and implement suitable training programs. Accordingly, this study illustrated how various types of training affect financial efficiency and how they contribute to a deeper awareness of the potential direction of future actions.

It is also essential to understand how the financial efficiency of agricultural cooperatives influences governance indicators. The empirical results of the study showed the mixed effects of governance indicators and financial efficiency, which have important policy implications. The main idea of the South African government is to incentivise agricultural cooperatives to be efficient and to promote sustainable businesses. Governance indicators that promote financial efficiency imply that cooperatives should comply with these indicators, as policymakers and practitioners can then actively encourage compliance with these governance indicators. However, governance indicators that imply that agricultural cooperatives should not comply with these indicators, in order to become financially efficient, are problematic in at least two ways: firstly, they suggest that there are governance indicators that create inefficient incentives, and secondly, that these indicators may not be aligned with promoting a business. Therefore, the current policy should ensure that the governance indicators incentivise financial efficiency among agricultural cooperatives. The policy may also need to be addressed so that these governance indicators align with the promotion of the business of cooperatives.

Another important point that was highlighted in this study was that although older cooperatives are more financially efficient, compared to younger cooperatives, cooperatives can get too old, which will lead to lower levels of financial efficiency. Therefore, information regarding the stage of the cooperative can be provided by gathering more information about the age of the cooperative. Time series or panel data can provide more in-depth information that can reveal at which stage a given cooperative is.

This study could help agricultural cooperatives to come up with strategic decisions that are necessary for competing in a dynamic market. Under-achieving cooperatives should consider learning from their successful peers. Another important consideration could be the adoption and modification of business plans from market leaders in the sector i.e., either cooperatives of the same or different types, or both.

From a policy perspective, the findings of this study have a role to play in the implementation of relevant regulatory mechanisms to direct agricultural cooperatives towards achieving financial efficiency in SA. One main limitation of the current study was the use of cross-sectional data. The dataset failed to account for the changes in productivity of agricultural cooperatives over time. It is, therefore, recommended that future research should focus on these changes.

Disclosure statement

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Appendices

Appendix 1. Rotated component matrix for group membership

	Component							
	1	2	3	4	5	6	7	8
Female members attended the recent AGM (FEAGM)	0.989							
Female members attended previous year's AGM (FEPRAGM)	0.983							
Active female members (ACTFEM)	0.980							
Active youth members (ACTYTH)	0.980							
Registered youth members (REGYTH)	0.978							
Youth members attended recent AGM (YTHAGM)	0.977							
Male members attended the recent AGM (MALEAGM)	0.962							
Male members attended the previous AGM (MAPRAGM)	0.962							
Active male members (ACTMALE)	0.960							
Registered female members (FEMREG)	0.931							
Registered male members (MALEREG)	0.917							
Female full-time employees (FEMFT)		0.967						
Male full-time employees (MALEFT)		0.940						
Youth full-time employees (YTHFT)		0.914						
Female committee chairperson (FEMCOMCHR)			−0.877					
Male members in management committee (MALEMCOMM)			0.834					
Male committee chairperson (MALECOMCHR)			0.653					
Female manager (FEMMGR)			−0.653					
Disabled members attended previous year's AGM (DISAGM)				0.947				
Registered disabled members (DISREG)				0.939				
Male part time employees (MALEPT)					0.837			
Female part time employees (FEMPT)					0.756			
Male members in management committee (MALEMCOMM)					0.507			
Youth members in management committee (YTHMGTCOM)						0.738		
Youth committee chairperson (YTHCOMCHR)						0.622	0.484	
Youth part-time employees (YTHPT)					0.416	0.459		
Youth manager (YTHMGR)							0.887	
Disabled full time employees (DISFT)								0.687
Female members in management committee (FEMCOM)								0.580

Appendix 2. Total variance explained for group membership

	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.957	37.781	37.781	10.957	37.781	37.781	10.554	36.393	36.393
2	2.949	10.170	47.951	2.949	10.170	47.951	2.822	9.730	46.124
3	2.462	8.491	56.442	2.462	8.491	56.442	2.574	8.875	54.999
4	1.874	6.462	62.904	1.874	6.462	62.904	1.971	6.795	61.794
5	1.765	6.087	68.991	1.765	6.087	68.991	1.859	6.411	68.206
6	1.397	4.819	73.810	1.397	4.819	73.810	1.383	4.769	72.974
7	1.180	4.068	77.878	1.180	4.068	77.878	1.228	4.235	77.209
8	1.002	3.454	81.332	1.002	3.454	81.332	1.195	4.122	81.332
9	0.895	3.086	84.418						
10	0.787	2.714	87.133						
11	0.705	2.431	89.564						
12	0.664	2.289	91.853						
13	0.616	2.126	93.979						
14	0.573	1.975	95.954						
15	0.322	1.112	97.065						
16	0.241	0.832	97.897						
17	0.203	0.702	98.599						

(*Continued*)

Continued.

	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
18	0.143	0.493	99.092						
19	0.122	0.422	99.514						
20	0.061	0.211	99.726						
21	0.038	0.132	99.858						
22	0.023	0.078	99.936						
23	0.008	0.027	99.963						
24	0.005	0.019	99.982						
25	0.003	0.010	99.992						
26	0.001	0.004	99.996						
27	0.001	0.002	99.998						
28	0.000	0.001	99.999						
29	0.000	0.001	100.000						

Appendix 3. Total variance explained for group membership for agricultural cooperatives' size of operations and borrowing size

	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.167	43.345	43.345	2.167	43.345	43.345	2.038	40.768	40.768
2	1.423	28.450	71.796	1.423	28.450	71.796	1.551	31.027	71.796
3	0.767	15.343	87.138						
4	0.352	7.035	94.173						
5	0.291	5.827	100.000						

Appendix 4. Component matrix for agricultural cooperatives' size of operations and borrowing size

	Component	
	1	2
Expenditure *p*/a last year (R)	0.752	−0.410
Turnover *p*/a last year (R)	0.794	−0.372
Annual wages last year (R)	0.795	0.004
Total owed to creditors	0.489	0.754
Outstanding Loans(banks)	0.314	0.740