FACTORS INFLUENCING THE LONG-TERM COMPETITIVENESS OF COMMERCIAL MILK PRODUCERS IN SOUTH AFRICA

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Abstract

This study investigates factors influencing the long-term competitiveness, based on a unit cost ratio analysis, of 11 commercial milk producers from East Griqualand (EG), South Africa, using unbalanced panel data for the period 1990 – 2006. Results of a Ridge regression analysis show that dairy herd size, the level of farm debt, production per cow, technological and policy changes over time, and the proportion of trading income to total milk income influence the long-term competitiveness of these milk producers. To enhance their competitiveness in a deregulated agricultural market, relatively small and profitable EG milk producers should consider increasing herd sizes as the importance of herd size in explaining competitiveness suggests that size economies exist. All EG milk producers should also consider utilising more pasture and other forages to lower production costs and select dairy cattle of superior genetic merit to improve milk yields.

Keywords: Milk production; South Africa; competitiveness; panel data

1. Introduction

Over the past 20 years the agricultural sector in South Africa has undergone major structural change as the country has followed the global trend of liberalising the marketing of its agricultural products. Since 1990 the South African (SA) dairy industry has experienced declining producer numbers and an expansion in dairy farm sizes. Milk producer numbers have declined from 9279 in 1990 (Collins, 1994:61) to 3655 in 2008, while the average number of cows-in-milk per producer has risen from 88 in 1998 to 151 in 2008 (Coetzee and Maree, 2008). Another structural change in the SA dairy industry has been a shift in the geographic distribution of milk production from inland to coastal areas (Coetzee and Maree, 2008). Blignaut (1999) contends that the impetus for this shift has been the popularisation of pasture-based production systems, which are more suited to coastal areas. Lower collection costs per square-kilometre, due to less dispersion of milk producers, also makes coastal areas more attractive to milk buyers. Coastal areas (Western and Eastern Cape and KwaZulu-Natal) accounted for 68.4% of total SA milk production in 2007 (Coetzee and Maree, 2008).

In a changing policy environment milk producers can improve the financial position of their farm businesses by understanding the factors that influence profitability (Short, 2000). As competitors in the global dairy market, SA milk producers need to re-position themselves and become more innovative and responsive to future changes. It is critical, therefore, that factors which may enhance or restrict competitiveness at the milk producer level in the long term are identified. Based on a definition by Esterhuizen (2006:89), competitiveness in this study is defined as the ability of a milk producer to achieve sustainable business growth while earning at least the opportunity cost of management. A microeconomic indicator of competitiveness, the Unit Cost Ratio, developed by Siggel and Cockburn (1995), is used to measure the long term competitiveness of 11 commercial milk producers from East Griqualand, South Africa. Since the Unit

Cost Ratio is a ratio of total enterprise costs to total enterprise revenue, it can also be considered a measure of enterprise profitability.

Previous producer-level studies have varied in their approaches to measuring the competitiveness or profitability for agricultural commodities. Some studies have focused on production cost measures of competitiveness (Blignaut, 1999; Tauer, 2001), whilst others have used profitability measures such as Return on Assets (Gloy *et al.*, 2002) and Net Farm Income (El-Osta and Johnson, 1998; Short, 2000). Previous research found a strong link between farm size (total numbers of cows), milking rate (production per cow) and dairy farm profitability (El-Osta and Johnson, 1998; Short, 2000; Gloy *et al.*, 2002). Other factors that significantly affected profitability were forage and feed costs per cow (El-Osta and Johnson, 1998), milkings per day and debt-to-asset ratio (DA) (Gloy *et al.*, 2002; Short, 2000), and specialization in dairy farming (El-Osta and Morehart, 2000; Short, 2000). Although much of the previous research investigated the effects of production, financial management and human capital factors on the performance of a dairy enterprise, none have considered the effect of dairy trading income[1] on the long-term performance of the dairy enterprise. Also, much of the previous research has not investigated the factors influencing competitiveness *over time*. This study aims to update past research by empirically investigating the factors affecting the *long term* competitiveness of the sample of EG commercial milk producers.

2. Data collection and key characteristics of EG milk producers

East Griqualand (EG) is located on the eastern seaboard of South Africa and is a summer rainfall region. Average annual rainfall ranges from 620mm to 816mm (Camp, 1999). Data from a sample of 11 commercial milk producers from the EG study group were collected for the period 1990 to 2006. The group has received advice from the same consultant over the study period, and current membership of

[1] Trading income = (livestock sales + herd closing value) – (livestock purchases + herd opening value)

the study group is 23 milk producers. A sample of 11 producers is used in this study due to entries and exits from the study group and incomplete individual datasets. The sample of milk producers represents 48% (11/23) of the current group and is, according to Bischoff (2008), typical of EG milk producers. Formed in 1983, the group's objective is to improve the production and financial performance of its members. The total sample size for the panel of EG milk producers is 187 (17 years × 11 milk producers) with 10 observations missing from the dataset.

Table 1 shows key physical and financial characteristics of the sample of EG milk producers from 1990 to 2006. Over the study period, mean real prices and total costs per litre for the sample of EG milk producers have declined marginally. These producers have expanded the size of their dairy enterprises over the study period, from a mean of 143 to 299 cows in milk. The debt-to-asset ratio fluctuated marginally and relatively higher debt during the 1996 to 2001 period may have been used to fund dairy enterprise expansion over this period. The enterprise mix shows that the sample of farmers are somewhat diversified, although specialisation in milk production has intensified with milk income increasing from 69% to 79% of gross farm income over the study period.

3. Research methodology

The study uses Ridge regression - a modification of Ordinary Least Squares (OLS) regression - with imputed observations to estimate factors influencing the competitiveness of the unbalanced panel dataset of 11 commercial milk producers in EG for the period 1990 - 2006. The data were analysed using SAS Version 9.1 Statistical Package for Windows (SAS Institute Inc, 2003).

Panel data regression analysis differs from conventional time series and cross-section regression analyses in that time series as well as cross-section dimensions are incorporated into the model's structure (Baltagi, 2005:11). There is substantial debate on the suitability of either a random or fixed effects model for a panel data

set. Since this study examines firm-specific effects, a fixed effects specification model was considered to be the most appropriate.

Table 1: Mean physical and financial characteristics of a sample of EG milk producers, 1990 - 2006

Milk producer characteristics		1990 – 1995 n = 63*	1996 – 2001 n = 63*	2002 – 2006 n = 51*
Real milk price[a] (R/litre)		**1.52**	**1.42**	**1.49**
Real costs[a,b] (R/litre)		**1.55**	**1.40**	**1.40**
Dairy herd size (cows in milk)		**143**	**202**	**299**
Production per cow (Litres per annum)		**5180**	**4882**	**4585**
Enterprise Mix (% contribution to gross farm income)	**Dairy**	**69**	**70**	**79**
	Beef	**10**	**9**	**7**
	Sheep[c]	**7**	**3**	**1**
	Cash crops	**6**	**10**	**4**
	Maize	**5**	**5**	**7**
	Other income	**3**	**3**	**2**
Debt-to-asset ratio[d]		**0.33 (0.38)**	**0.35 (0.39)**	**0.32 (0.49)**
Pasture and forage feed cost to total feed cost (TFC) (% of TFC)		**39%**	**43%**	**48%**
Trading income to total income (% of total milk income)		**13%**	**10%**	**11%**

Source: Bischoff (2008)
* periods 1990-1995 and 1996-2001 consist of 6 years of data while period 2002-2006 has 5 years of data.
a. 2000 = 100; US$1 = R6.93 in 2000 (R = Rand) (South African Reserve Bank, 2009)
b. Total real costs include an opportunity cost of management at 5% of milk turnover (following Calkins and DiPetre 1983:117).
c. The sheep enterprise includes income from the sale of wool.
d. Range of debt-to-asset ratio shown in parentheses

Equation (1) shows the general form of a fixed effects regression model used in this study:

$$Y_{it} = \alpha_1 + \alpha_k D_{ki} + \beta_l X_{lit} + \mu_{it} \quad (1)$$

Where i denotes individual milk producers, t denotes time, α_1 represents the intercept of the base category producer, α_k is a differential intercept coefficient

indicating the difference between α_1 and the intercepts of the other milk producers (k = 2,..., 11), D_{ki} is a differential intercept dummy variable, β_l is the coefficient of explanatory variable X_l (l = 1,..., 7 explanatory variables), and u_{it} is the error term.

Variables that were considered in the fixed effects panel regression model are presented and defined in Table 2. The Unit Cost Ratio (UCR) method is used to measure producer competitiveness in this study and is defined as the ratio of total dairy enterprise costs to total revenue for producer *i* at time *t* (following Siggel and Cockburn, 1995). Total costs include dairy enterprise accounting costs plus an opportunity cost of management computed at 5% of total milk turnover (Calkins and DiPietre, 1983:117).

Table 2: Definition of variables used in fixed effects regression model

Variables	Definition	Expected sign of β/α coefficients
UCR_{it}	Unit Cost Ratio: Measure of milk producer competitiveness (dependent variable).	
$COWS_{it}$	Dairy herd size (number of cows in milk).	–
$PRODCOW_{it}$	Production per cow (litres per annum).	–
$SPECIALISE_{it}$	Specialisation index (proportion of gross farm income made up of milk income).	–
$TRADINC_{it}$	Proportion of trading income to total milk income.	–
$PASCOST_{it}$	Proportion of pasture and forage costs to total feed costs.	–
$DEBTASSET_{it}$	Proportion of farm assets financed by debt capital.	+
$YEAR_t$	Trend variable	+/-
D_i	Individual milk producer dummies	+/-

The UCR_{it} indicator is interpreted as follows: a score of >1 indicates that producer *i* earned negative land rents (returns to land) at time *t* and was *not competitive* (total costs > total revenue). A score of <1 indicates that producer *i* earned positive land rents at time *t* and was *competitive* (total costs < total revenue).

El-Osta and Johnson (1998), El-Osta and Morehart (2000), Short (2000) and Gloy *et al.* (2002) have used dairy herd size as a measure of dairy farm size. For the purposes of this study, the natural logarithm of size, $LNCOWS_{it}$ was used. It is hypothesised that there will be a negative relationship between farm size and UCR_{it} because dairy herd (farm) size could be positively related to profitability, *ceteris paribus*. Therefore, as dairy herd size increases, UCR_{it} is expected to decrease, indicating an improvement in competitiveness. El-Osta and Johnson (1998), Short (2000) and Gloy *et al.* (2002) have found that milking rate (production per cow) is significantly related to farm profitability. It is hypothesised, therefore, that a higher milk production per cow, $PRODCOW_{it}$, will enhance milk producer competitiveness and therefore lower UCR_{it}, *ceteris paribus.* The specialisation index, $SPECIALISE_{it}$, was used in preference to more complex measures of diversification and is defined as the proportion of total milk enterprise income to farm income (El-Osta and Morehart, 2000). Since previous research has shown that greater specialisation in dairy farming is positively related to enterprise profitability (El-Osta and Johnson, 1998; El-Osta and Morehart, 2000; Short, 2000), it is hypothesised that as a milk producer becomes more specialised in milk production, competitiveness improves (UCR_{it} declines), *ceteris paribus.*

According to Bischoff (2008), dairy enterprise trading income, $TRADINC_{it}$, is an important contributor to the overall profitability of a dairy enterprise. Milk producers with a greater proportion of trading income to total milk income could thus be more competitive than milk producers with a lesser proportion, *ceteris paribus*. The $PASCOST_{it}$ variable measures the ratio of forage and pasture costs to

total feed costs. In recent years many SA producers have followed the New Zealand pasture-based system due in part to lower feed costs (Bischoff, 2008). A higher ratio of pasture costs to total feed costs is, therefore, expected to improve competitiveness (UCR_{it} declines), *ceteris paribus*. $DEBTASSET_{it}$, a measure of farm solvency, was also included in the model. Data on debt level attributable exclusively to the dairy enterprise was not available and, therefore, the farm business debt-to-asset ratio was used[2]. The use of debt has been shown by previous research to negatively affect profitability as by using debt the producer is obligated to pay interest (and principal) (El-Osta and Johnson, 1998; Short, 2000; Gloy *et al.*, 2002). Therefore, as debt use increases, competitiveness is expected to decline (UCR_{it} increases), *ceteris paribus*. A trend variable, $YEAR_t$, is used as a proxy to capture the effects of technology, policy and other changes over the study period. Ten dummy variables, D_i, were added to the model to account for differences among the 11 milk producers. The base category milk producer selected had the largest dairy herd size (1472 cows in milk) in 2006 and was chosen so that differences between milk producers could be better highlighted.

4. Results and discussion

The results of the fixed effects Ridge regression model for the panel of EG milk producers are presented in Table 3. Fifty-eight percent of the variation in UCR_{it} was explained by the independent variables. The coefficient estimate for dairy herd size, $LNCOWS_{it}$, had the expected negative sign which supports *a priori* expectations that the size of the dairy enterprise influences competitiveness in the long term and provides evidence of returns to size on EG dairy farms. The estimated coefficient of $PASCOST_{it}$ was found to have the correct sign but was not a statistically significant determinant of long-term competitiveness for the 11 EG milk producers. The negative sign of the estimated coefficient suggests, however, that increased utilisation of forage and pasture enhances competitiveness.

[2] The dairy enterprise, however, contributed on average from 69% to 79% of total farm income over the study period.

Table 3: Results of fixed effects Ridge regression for panel of EG milk producers, 1990 – 2006 (n=187)

Parameter	β-coefficient	Standardised coefficient	Std error	t - statistic
LNCOWS	-0.0352	-0.182	0.0527	-6.68***
PASCOST	-0.0264	-0.0408	0.0189	-1.40
TRADINC	-0.198	-0.0902	0.0678	-2.93***
SPECIALISE	1.60×10^{-3}	2.60×10^{-4}	0.0152	-0.105
PRODCOW	-1.64×10^{-5}	-0.133	3.45×10^{-6}	-4.75***
YEAR	-2.73×10^{-3}	-0.122	6.54×10^{-4}	-4.17***
DEBTASSET	1.90×10^{-3}	0.171	3.09×10^{-4}	6.15***
	α-coefficient			
Base category	1.235		0.0394	31.3***
$\mathbf{D_2}$	-0.0231	-00610	0.0107	-2.16**
$\mathbf{D_3}$	-0.0347	-0.0916	0.0109	-3.18***
$\mathbf{D_4}$	0.0282	0.0744	0.0110	2.56***
$\mathbf{D_5}$	0.0126	0.0332	0.0112	1.12
$\mathbf{D_6}$	0.0153	0.0404	0.0114	1.34
$\mathbf{D_7}$	3.64×10^{-4}	9.61×10^{-4}	0.0107	0.0340
$\mathbf{D_8}$	0.0575	0.152	0.0107	5.37***
$\mathbf{D_9}$	-0.0248	-0.0655	0.0109	-2.28**
$\mathbf{D_{10}}$	0.0246	0.0649	0.0107	2.30**
$\mathbf{D_{11}}$	-0.0175	-0.0462	0.0984	-1.78*
	$R^2 = 0.58$		Adjusted $R^2 = 0.54$	
	F- statistic = 13.7***		*d* = 2.29	

Note: *,**,*** denote significance at the 10%, 5% and 1% levels of probability respectively

The coefficient estimate of $TRADINC_{it}$ is statistically significant and has the expected sign, supporting *a priori* expectations that trading income affects the overall profitability and competitiveness of the EG dairy enterprise. The coefficient estimate of $SPECIALISE_{it}$ did not have the expected sign and was not statistically significant. Diversification is a risk management strategy for the EG milk producers, as shown in Table 2, and although over the study period 1990 to 2006 the contribution of milk income to gross farm income has increased from 69% to 79%, the benefits of diversification may still outweigh those of specialisation in EG. The coefficient estimate of $PRODCOW_{it}$ has the expected negative sign and was statistically significant. Higher producing dairy cattle, therefore, have a positive influence on long term competitiveness of these producers. The coefficient estimate of $YEAR_t$ was statistically significant and had the expected negative sign, showing that the competitiveness of these producers has been improving over time. This outcome suggests that the panel of EG milk producers have adapted favourably to policy change over the study period; they have become more efficient (producing at lower cost per litre) by adopting strategies and technologies that enhance their competitiveness in a deregulated environment. The coefficient estimate of $DEBTASSET_{it}$ was statistically significant and suggests that the level of farm debt influences the competitiveness of EG milk producers in the long term. The positive sign of the estimated coefficient shows that as relative farm debt levels increase, competitiveness declines, *ceteris paribus*. The coefficient estimates of D_2, D_3, D_4, D_8, D_9, D_{10} and D_{11} are statistically significant. The negative signs of the estimated coefficients of D_2, D_3, D_9 and D_{11} and positive signs of the estimated coefficients of D_4, D_8 and D_{10} indicate that these producers were significantly *more* and *less* competitive, respectively, than the base category producer.

The standardised coefficients, which show the relative contribution of each explanatory variable to the explanation of the dependent variable (UCR_{it}), indicate that $LNCOWS_{it}$, $DEBTASSET_{it}$ and $PRODCOW_{it}$ contribute relatively more to

the explanation of UCR_{it} than do $YEAR_t$ and $TRADINC_{it}$. This finding is consistent with other studies.

5. Conclusions and recommendations

The results of the study show that size of the dairy enterprise, debt level of the farm business, production per cow, technological and policy changes and the ratio of trading income to total milk income influence the long-term competitiveness of the sample of EG milk producers. The findings are consistent with those of similar studies.

To enhance competitiveness in a deregulated agricultural market, small (relative to the base category producer), profitable EG milk producers should consider increasing their dairy herd size to make use of size economies. All EG milk producers should consider utilising more pasture and forage in their production systems (to lower feed costs) and to select dairy cattle of superior genetic merit that produce high milk yields on pasture. Trading income will continue to play an important role in determining the overall profitability of the dairy enterprise.

This study is a meaningful update on the work done by Blignaut (1999), who used an integrated approach to assess the competitive advantage in the SA dairy industry, as this study identified some important determinants of long-term competitiveness for a sample of EG milk producers. Areas for further research include extending the analysis to investigate the determinants of producer competitiveness in other major milk producing regions in South Africa, such as the Eastern and Western Cape. The inclusion of human capital and management factors (such as age, education and experience), which may impact on the competitiveness of SA milk producers, may also add value to further research. These factors were omitted in this study due to the type of data available and the length of the study period as it was assumed that milk producers would not be able to provide reliable estimates of decisions made more than 10 years ago.

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