TESTING THE ASSOCIATION BETWEEN PRODUCTION AND FINANCIAL PERFORMANCE

Evidence from a not-for-profit, cooperative setting

by

Andrew WORTHINGTON*

School of Economics and Finance,
Queensland University of Technology.

This is the author-manuscript version of this paper. Published in:

Worthington, Andrew (1998) Testing The Association Between Production And Financial Performance Evidence from a not-for-profit, cooperative setting . Annals of Public and Cooperative Economics 69(1):pp. 67-84.

ABSTRACT: *A sample of sixty-three Australian credit unions is used to compare the financial performance measures provided by accounting-based financial ratios, and production performance as measured by efficiency indices. Whilst the evidence found supports the posited association between financial ratios and efficiency indices, the usefulness of such information is contingent upon which set of a priori behavioural assumptions have been used. More particularly, the results question the applicability of a traditional profit-based, physical production approach to a not-for-profit, cooperative setting.*

1 Introduction

The definition, measurement and improvement of institutional performance, and the provision of this information, is of critical importance to not-for-profit, cooperative deposit-taking institutions. On the one hand, there are the disparate requirements of current and potential members, managers, regulators, and other interested parties. Performance information in this regard may relate to issues of profitability, strength/soundness, efficiency and credit quality. And on the other, there are the institutional and regulatory frameworks and the direct and indirect costs associated with the supply of such assessments and disclosures. Here one should consider the lack of capital and corporate control market forces, the competitive disadvantage costs, and the constraints placed upon managerial behaviour.

Traditionally, much of the requisite information – or at least that found in the public domain – has been derived from accounting-based financial ratios. And two largely independent strands of thought have been used to analyse this information. The first approach is essentially normative, where an institution's ratios are compared with some pre-set standard. This approach has been used for making performance comparisons within the financial services industry. The second approach has been the positive use of ratios in an attempt to establish functional relationships; usually as predictors of liquidity distress. And whilst both techniques serve to illuminate many aspects of a financial institution's activities, three main problems arise.

---

* The author would like to thank Hal Fried of Union College, Knox Lovell of the University of Georgia, Neil Esho of the University of New South Wales, Raylene Brown of the University of Melbourne and two anonymous referees for helpful comments on an earlier draft of this paper. The financial assistance of a University of New England Internal Research Grant is also gratefully acknowledged.

First, one of the most fundamental limitations of univariate analysis is that only two dimensions of activity, represented by numerator and denominator, can be examined in any one indicator (Smith 1990: 131). For example, a typical ratio may examine some output in relation to an input. A problem that immediately arises is that such a measure is made on an assumption of constant returns to scale, and is, by definition, strictly linear. Yet it also is obvious that firms are multi-dimensional entities: a single measure is unlikely to reflect the complexity of decision-making or the scope of a institution's entire activities (Athanassopoulos and Ballantine 1995). Second, a number of somewhat more prosaic problems may also arise. For example, there is the problem of how to treat outliers; the difficulties which may occur when either the numerator or denominator takes negative values; or the violation of the distributional assumptions found in statistical analysis.

However the final, and much more fundamental limitation, is that the adoption of such 'financial performance' measures has, in many cases, been made without due regard for the behavioural assumptions under which many institutions within the financial services industry operate. That 'not-for-profit', 'cooperative' deposit-taking institutions perform an important function in the financial services industry requires no further comment. That these same institutions can be properly assessed on the basis of financial measures derived from commercial banking is a matter of far less certainty. And yet, managers and regulators, amongst others, have almost universally adopted financial ratios as the sole tool of performance analysis. Finding a viable alternative to financial performance alone is an area that remains largely unexplored.

One alternative to the use of financial performance measures that does suggest itself is the application of the economic notion of a production function and an efficiency frontier to performance assessment.[1] More particularly, an approach known as data envelopment analysis (DEA) may serve to offer useful insights into the efficiency with which credit union management is translating the various resources at its disposal into outputs – that is, measures of 'productive performance' (Elyasiani and Mehdian 1994; Yeh 1996; Thanassoulis, Boussofiane and Dyson 1996). In this paper, the information content of financial ratios about the efficiency performance of not-for-profit, cooperative financial institutions is investigated. If, and as it has been hypothesised, there are linkages between financial and productive performance, then such associations should be tested and quantified.

The paper itself is divided into four main areas. Section 2 discusses the measures of financial and productive performance to be applied to a sample of sixty-three Australian credit unions. Section 3 reviews the data and the results are dealt with in Section 4. The paper ends with some brief concluding remarks.

2 Empirical methodology

2.1 Measures of production performance

The technique employed in the current paper is based on the data envelopment analysis (DEA) approach first popularised by Charnes, Cooper, and Rhodes in 1978. In turn, Charnes, Cooper and Rhodes (1978) is a mathematical programming reformulation of the Farrell (1957) single-output/input technical-efficiency measure to the multiple-output/multiple-input case. The subsequent technical development of DEA is extensive, certainly to the point of precluding a survey in this instance. Interested parties are directed to those provided by Seiford and Thrall (1990), Ali and Seiford (1993), and Charnes, Cooper, Lewin, and Seiford (1993).

In a nutshell, DEA is a linear programming-based methodology designed to measure the efficiency of 'decision making units' or DMUs. Typically, each of the DMUs in a given population use the same multiple inputs in varying quantities to produce varying quantities of the same multiple outputs. Using the actual observed values for the inputs and outputs for each DMU, DEA constructs a piecewise extremal production surface, which in economic terms represents the revealed best-practice production frontier – the maximum output empirically obtainable for any DMU in the observed population, given its level of inputs. The distance to the frontier and a measure of efficiency are then assessed using a mathematical method.

Having illustrated DEA intuitively, we may extend the technique to the multiple-output, multiple-input case, following Charnes, Cooper and Rhodes (1978). Consider S DMUs each producing m different outputs using n different inputs. The efficiency of the DMU is measured as follows:

$$h_s = \sum_{i=1}^{m} u_i y_{is} \Big/ \sum_{j=1}^{n} v_j x_{js} \qquad (1)$$

where y_{is} is the amount of the ith output produced by the sth DMU, x_{js} is the amount of the jth input used by the sth DMU, u_i is the output weight, v_j is the input weight, i runs from 1 to m, and j runs from 1 to n. The efficiency ratio (h_s) is then maximised subject to the following:

$$\sum_{i=1}^{m} u_i y_{ir} \Big/ \sum_{j=1}^{n} v_j x_{jr} \leq 1, \quad \text{for } r = 1, \ldots N \text{ and } u_i \text{ and } v_j \geq 0 \qquad (2)$$

where the first inequality ensures that the efficiency ratios for all DMUs cannot exceed one, whilst the second ensures that the weights are positive. The weights are determined such that each DMU maximises its own efficiency ratio. This fractional linear program (2) can be transformed into the following equivalent linear programming (LP) problem:

$$\begin{aligned} \max \ w_s &= \sum_{i=1}^{m} u_i y_{is} \\ \text{subject to } \sum_{j=1}^{n} v_j x_{jr} &= 1 \\ \sum_{i=1}^{m} u_i y_{ir} - \sum_{j=1}^{n} v_j x_{jr} &\leq 0 \\ u_j &\geq \varepsilon \\ v_j &\geq \varepsilon \end{aligned} \qquad (3)$$

whose LP dual problem is:

$$\begin{aligned} \min \ z_s &= \theta - \varepsilon \sum_{i=1} s_i^+ - \varepsilon \sum_{j=1} s_i^- \\ \text{subject to } \sum_{s} \lambda_r Y_r - s^+ &= Y_s \\ \theta X_r - \sum_{r} \lambda_r X_r - s^- &= 0 \\ \lambda_r, s_j^+, s_j^- &\geq 0 \end{aligned} \qquad (4)$$

where Y is the $r \times m$ matrix of output measures, and X is the $n \times r$ matrix of input measures. The variable θ is the proportional reduction applied to all inputs of a DMU to improve efficiency, whilst ε is a non-Archimedean (infinitesimal) constant which effectively allows the minimisation of θ to preempt the optimisation involving the slacks (s^+ and s^-). The vector λ defines a point on the envelopment surface. This point is either a linear combination of units that lie on the surface of the envelopment surface in the case of constant returns to scale (CRS) model or a convex combination for the variable returns to scale (VRS) formulation. The value z_s (= w_s) yields an efficiency rating that measures the distance that a particular DMU being rated lies from the frontier. Thus, a DMU is efficient only if $z = 1$ and all slacks are zero. The nonzero slacks and the value of $\theta \leq 1$ identify the sources and amount of any inefficiencies that may be present.

The programs detailed provide the input-orientated constant returns to scale envelopment surface, and a measure of overall technical efficiency (z_s). Under these assumptions, any scaled-up or scaled-down versions of the input combinations are also included in the production possibility set. The overall technical efficiency can then be further divided into pure technical and scale efficiency following Banker, Charnes and Cooper (1984). Adding the convexity constraint ($\sum \lambda_r = 1$) to (4) allows for variable returns to scale and provides a measure of pure technical efficiency (π_s), whilst dividing overall technical efficiency by pure technical efficiency yields a measure of scale efficiency ($\mu_s = z_s/\pi_s$). Suitable graphical expositions of DEA efficiency measures may be found in Favero and Papi (1995), Drake and Weyman-Jones (1996) and Cubbin and Zamani (1996).

2.2 Measures of financial performance

The final methodological requirement for comparing measures of production and financial performance consists of two stages. The first stage involves calculating a set of commonly-used financial ratios for each credit union: *OE*/*TA* which is the ratio of operating expenses to total assets; *OI*/*OE* the ratio of operating income (net interest income plus non-interest income) to operating expense; *OI*/*L* operating income per unit of labour; and finally *OI*/*B* operating income per branch. On the basis of these financial performance measures alone, a highly performing credit union will be one which has a low ratio of operating expenses to totals assets, a high income to expense ratio, and high level of operating income per employee or branch.

The second stage involves testing the association between these financial performance measures and the DEA efficiency measures. This is accomplished using a regression approach. Given that the DEA efficiency measures represent a standard case of 'censored regression', Tobit estimation is appropriate. The following general form is proposed:

$$y_i = \beta' x_i + \varepsilon_i,\ \varepsilon_i \sim N[0, \sigma^2] \qquad (5)$$

where x comprises the vector of financial performance measures posited to influence the level of production efficiency, y, for the ith credit union, β is a set of parameters to be estimated, and ε reflects unobserved variables that affect y.

A further issue that does arise is the role of external factors which may exert an influence on efficiency differentials: even though the present study's focus is on the association between measures of financial and production performance. Examples may include differences in location, surrounding market structure, and regulation. For this purpose, two sets of dummy variables are included in the regression analyses to account for possible locational and institutional factors. The first set relates to the location of each credit union by state (numbers of institutions in brackets): Victoria (12), New South Wales (26), Queensland (9), Western Australia (4), South Australia (6), Tasmania (3) and other (3). The second set relates to the bond under which the credit union was originally created, either industrial (36) or community/parish-based (27). The incorporation of these variables is consistent with previous work in this area.

3. Data and hypotheses

The variables used to calculate the measures of production and financial performance are detailed in Table 1. All data corresponds to the financial year ending 30 June 1995 and is obtained from the Australian Financial Institutions Commission (AFIC). Variables are denominated in either dollars or units, and apply to a sample of sixty-three major credit unions. The intermediation approach is used to specify the input/output relationship for the measures of production performance: financial institutions act as intermediators, converting and transferring financial assets from surplus units to deficit units. In the usual case, the inputs are labour and capital costs and the interest payable on deposits, with the outputs denominated in loans and financial investments. Descriptive statistics are provided in Table 2.

TABLE 1–Summary of variables and specifications

Variables	Specification				
	1	2	3	4	5
Inputs					
Operating expenses (marketing, salaries, office occupancy and electronic data processing)	•	•	•	•	•
Total assets (financial assets plus fixed assets)	•	•	•	•	•
Number of branches (includes head office, excludes agency operations)	•	•	•	•	•
Labour (full-time equivalent)	•	•	•	•	•
Interest expense on retail funds		•	•		
Interest expense on non-retail funds		•	•	•	•
Outputs					
Profit after tax	•				
Interest income on retail funds		•		•	
Interest income on non-retail funds		•	•	•	•
Non-interest income (includes proceeds from sale of assets, fees, and all other income)		•	•	•	•
Number of borrowers/depositors	•	•	•	•	•

The inputs and outputs in Table 1 are employed in several alternative specifications. Piesse and Townsend (1995: 401) propose five separate conceptualisations "...suggesting combinations of inputs (resource using) associated with one or more outputs (resource creating)". They rationalise such an approach on the basis that two disparate forces are at play within cooperative enterprises. First, whilst credit unions do operate in a competitive environment, their objectives are relatively complex. On the one hand, members are interested in minimising the cost of funds for mortgages and other loans, whilst on the other they seek a safe and profitable vehicle for savings. However, despite these conflicting views "...members do have an interest in minimising other costs (such as management expenses) and maximising other income (such as investing surplus liquid funds)" (Piesse and Townsend 1995: 400). At the very least, the diverse range of specifications will allow inferences to made about the sensitivity of such analyses to *a priori* assumptions, whilst still maintaining consistency with the established literature.

The first specification, represents a profit-based, physical production approach. Here the emphasis is on a conventional interpretation of corporate performance, with profit and membership being the only outputs. The inputs in this case are operating expenses, assets, the number of branches and the amount of labour. An extension of the first specification is contained in the second. Here there is an attempt to recognise the multiple objectives that a credit union might display, as well as the essential intermediation function. Additional outputs are concerned with interest and non-interest income, as well as the objective of maximising the number of depositors and lenders. Extra inputs are interest and non-interest expenses.

The third specification is a further extension of the second, except that interest income on retail funds is excluded (i.e. that derived from mortgages and personal loans). In the case of a credit union, members may argue that a suitable behavioural objective is the minimisation of the cost of funds to themselves, and therefore interest income is not an appropriate output measure. A similar cooperative strategy is extended to the fourth specification. Recognising that credit union members are also depositors, it may be perceived as inappropriate for the institution to minimise the interest paid on accounts. Finally, the last specification combines the proposition that "...it is not necessarily the role of credit unions to either maximise the interest earned on mortgages, or to minimise the interest paid to savers" (Piesse and Townsend 1995: 401). A credit union will be more efficient when minimising operating expenses, raising non-retail funds cheaply, and earning high returns on non-retail investments.

TABLE 2–Descriptive Statistics

Variables	Mean	Std. Dev.	Min.	Max.
DEA inputs and outputs				
Operating expense	8,011	5,489	2,079	25,913
Total assets	164,180	109,913	54,522	475,127
Number of branches	10	10	1	51
Labour	80	54	20	270
Interest expense on retail funds	6,798	4,884	2,049	24,401
Interest expense on non-retail funds	141	290	0	1,550
Profit after tax	1,640	1,310	271	5,093
Interest income on retail funds	13,666	9,021	4,070	40,572
Interest income on non-retail funds	1,720	1,345	477	7,121
Non-interest income	1,564	1,656	107	8,649
Number of borrowers/depositors	34,945	23,163	9,187	112,408
Financial ratios				
Operating expense to total assets	0.0498	0.0112	0.0165	0.7580
Operating income to operating expense	1.2636	0.1595	1.0579	1.9445
Operating income per unit of labour	128,560	34,584	81,785	261,890
Operating income per branch	1,625,000	223,540	244,200	1,959,200

In terms of the association model detailed in (5), the approach to explaining efficiency variation involves the estimation of five separate regressions, one for each input/output specification. The dependent variable in each case is the level of overall technical efficiency. The expected signs of the coefficients to be estimated are based upon the following hypotheses. For operating expense to total assets (OE/TA) the coefficient is expected to be negative, since the higher the ratio of operating expense to total assets the less efficiently a credit union is utilising its inputs to generate a given level of output. Conversely, the coefficient on the ratio of operating income to operating expense (OI/OE) is *a priori* expected to exhibit a positive sign, implying that efficiency is obtained through maximising output and minimising inputs. The same argument may be advanced *ex ante* for the signs on the coefficients for operating income per unit of labour (OI/L) and per branch (OI/B). All other things being equal, credit unions generating high levels of income relative to factor inputs will be more efficient. Finally, there is no unequivocal rationale for predicting the direction of the locational (VIC, NSW, QLD, WA, SA, TAS) and institutional (IND) variables. The main emphasis is ascertaining whether these factors together exert an influence on production performance.

4. Empirical results

Table 3 provides summary statistics for the various DEA efficiency measures. The measures obtained result from the standardisation of the total weighted distance between the observed and projected points by the virtual input: a specific DMU will only be efficient if, and only if, the measure of efficiency is equal to unity.

Turning to the first specification, the level of overall technical efficiency (z) indicates that the average Australian credit union could – and solely on the basis of observable best-practice – become efficient by reducing inputs to 72% of their current level. Alternatively, the average loss of productivity due to overall technical inefficiency is 28%. As a comparison, and recognising there are problems in comparing these relative measures across samples, studies of US credit unions by Fried, Lovell and Vanden Eekaut (1993) and Fried, Lovell and Turner (1996) have found productive inefficiencies of about 20 percent. As may also be seen in Table 3, a relatively small number of credit unions define the frontier in specification 1. In the case of overall technical efficiency only six credit unions (some ten percent) define the frontier, nineteen credit unions are on the frontier for pure technical efficiency, and only six credit unions are scale efficient. In the case of the latter, the measure of scale efficiency (μ) indicates that the average loss of productivity due to scale effects in the sample amounted to some 14%.

TABLE 3–Summary efficiency statistics

	1			2			3			4			5		
	z	π	μ	z	π	μ	z	π	μ	z	π	μ	z	π	μ
Mean	0.72	0.84	0.86	0.98	0.99	0.99	0.89	0.93	0.95	0.96	0.97	0.98	0.88	0.92	0.95
Std. Dev.	0.14	0.13	0.11	0.02	0.01	0.01	0.10	0.09	0.06	0.04	0.03	0.02	0.11	0.10	0.06
Minimum	0.41	0.55	0.45	0.89	0.91	0.94	0.47	0.48	0.76	0.85	0.85	0.89	0.47	0.48	0.71
# Frontier	6	19	6	42	50	43	20	34	20	30	40	30	33	17	1
% Frontier	10	30	10	67	79	68	32	54	32	48	63	48	52	27	0.02

Now, all other things being equal, as we move from the relatively simple behavioural objectives found in the first input/output specification, to the more complex formulations, more and more individual credit unions serve to define the frontier. For specification 2, where a greater variety of inputs and outputs are assessed, 67 percent of the sample are overall technically efficient, 79 percent are purely technical efficient, and 68 percent are scale efficient. This is entirely consistent with the programming methods employed: a higher number of outputs and inputs increases the options available for specialisation and allows a more diverse range of operational sizes. When the output of interest income on retail funds is excluded (specification 3) the average credit union has an overall level of technical efficiency of 0.89, and nearly thirty-two percent are deemed efficient. In the case of the fourth specification where the input of retail interest expense is excluded nearly fifty percent of the credit unions are overall technically efficient. Finally, discussing the formulation for specification 5, where 'member-orientated' behavioural objectives dominate more 'profit-orientated' ones, some 52 percent of credit unions are overall technically efficient, some 27 percent are purely technically efficient, but less than one per cent are scale efficient.

Whilst the measures of efficiency are of interest in themselves, the primary focus in the current study is on the consistency between these measures and commonly-used financial ratios in ranking credit union performance. Table 4 indicates the rank correlations between and among the measures of overall technical efficiency and the financial ratios.

As shown, the correlation based on the ranking of efficient credit unions using the measures of productive and financial performance vary substantially. Amongst the DEA specifications, 1 and

2 provide roughly agreeable rankings, as do 3, 4 and 5. Using a one-tailed test the null hypothesis of no positive association is rejected for both sets of rank correlations. The profit-maximising specification 1 provides rankings that are in relative disagreement with specifications 3, 4 and 5. Amongst the financial ratios alone, the closest rankings are found between the operating expense to total asset ratio and the income to expense ratio. One-tailed tests of the null hypothesis of no positive association are rejected between OI/OE and OE/TA, OI/OE and OI/L, and OI/L and OI/B.

TABLE 4–Rank correlations

1	1.000								
2	0.387***	1.000							
3	-0.335***	-0.151	1.000						
4	-0.053	-0.152	0.629***	1.000					
5	-0.260**	-0.123	0.963***	0.721***	1.000				
OE/TA	0.104	-0.198*	0.070	0.010	0.037	1.000			
OI/OE	0.454***	0.223*	-0.057	-0.098	-0.062	0.671***	1.000		
OI/L	0.213**	0.151	-0.204*	-0.242**	-0.225**	0.242**	0.309***	1.000	
OI/B	0.036	0.123	-0.305**	-0.230**	-0.269**	0.114	0.241**	0.408***	1.000
	1	2	3	4	5	OE/TA	OI/OE	OI/L	OI/B

Significant at the * – .10, ** – .05 and *** – .01 level.

In terms of ranking performance for cooperative financial institutions, the results indicate that simple univariate ratios will not rank institutions on a comparable level to efficiency measures. To start with, the expense to total asset ratio appears to bear little relation to the productive efficiency measures, regardless of the specification employed. On the other hand, the income to expense ratio partially approximates the ordering provided by the profit-maximising specification 1, but is in varying levels of disagreement with any of the specifications which attempt to define the unique behavioural objectives of cooperative financial institutions. Finally, operating income per unit of labour or branch appear to correctly identify less efficient credit unions, but only when the institution's objectives are orientated towards member's interests. Whilst these financial ratios may or may not be appropriate indicators of performance in other types of financial institutions, say commercial banks, it would appear that they are highly inappropriate for cooperative enterprises. This holds irrespective of the behavioural parameters assumed to underlie credit union behaviour.

The second part of the empirical examination of the relationship between financial performance and production performance requires the analysis of the regression coefficients detailed in (5). The estimated coefficients, elasticities (at the means), and standard errors are detailed in Table 5. In specifications 1 and 2, the coefficient on the ratio of operating expense to total assets is significant and positive. The results conflict with the hypothesis that credit unions with higher operating expense to total assets ratios tend to be less technically efficient. Whilst the sign does change in the regressions for specifications 3 – 5, the estimated coefficients are insignificant, even at the .10 level.

TABLE 5–Association with efficiency variation

	1		2		3		4		5	
	Coefficient	Elasticity	Coefficient	Elasticity	Coefficient	Elasticity	Coefficient	Elasticity	Coefficient	Elasticity
CONS.	-9.1144***		4.5727		11.2350***		16.1020***		10.8090***	
	(2.6400)		(6.3008)		(2.7934)		(3.3187)		(2.7244)	
OE/TA	68.5590***	0.4332	210.8200***	0.0212	-23.6530	-0.1147	-21.2430	-0.0428	-20.9630	-0.1112
	(18.7900)		(43.7130)		(18.6580)		(19.7990)		(18.4420)	
OI/OE	10.3030***	1.6504	17.6520***	0.0451	-2.0447	-0.2513	-0.7237	-0.0370	-1.8292	-0.2459
	(1.7215)		(3.8657)		(1.4302)		(1.4725)		(1.4105)	
OI/L	1.3E-05**	0.2164	1.9E-05*	0.0050	-5.2E-06	-0.0646	-4.7E-06	-0.0245	-6.6E-05	-0.0904
	(4.7E-06)		(1.1E-05)		(4.6E-06)		(5.1E-06)		(4.5E-06)	
OI/B	7.9E-08	0.0162	7.3E-08	0.0002	-1.4E-07**	-0.0220	-8.7E-08	-0.0057	-1.3E-07*	-0.0222
	(7.0E-08)		(1.5E-07)		(6.7E-08)		(7.0E-08)		(6.6E-08)	
VIC	0.2219	0.0054	-0.0786	0.0000	0.0892	0.0017	1.0051	0.0077	0.1249	0.0025
	(0.6530)		(1.1197)		(0.6533)		(0.7075)		(0.6516)	
NSW	-1.2083*	-0.0632	-0.6571	-0.0005	1.2936**	0.0519	0.6675	0.0111	1.2601*	0.0553
	(0.6344)		(1.1289)		(0.6406)		(0.6650)		(0.6388)	
QLD	-0.1834	-0.0033	1.0453	0.0003	0.4205	0.0058	-0.0004	0.0000	0.1047	0.0016
	(0.6750)		(1.1047)		(0.6779)		(0.7803)		(0.6747)	
WA	-1.3728*	-0.0110	6.5708	0.0008	1.5591*	0.0096	0.8218	0.0021	1.6074*	0.0109
	(0.7825)		(1.0E+05)		(0.8484)		(0.8633)		(0.8480)	
SA	-1.1892	-0.0144	0.1266	0.0000	0.4768	0.0044	0.7814	0.0030	0.4108	0.0042
	(0.7270)		(1.230)		(0.7211)		(0.7737)		(0.7205)	
TAS	-0.2532	-0.0015	0.3839	0.0000	0.4305	0.0020	0.4516	0.0009	0.4567	0.0023
	(0.8246)		(1.3425)		(0.8463)		(0.8749)		(0.8461)	
IND	-1.0358***	-0.0750	-0.7735	-0.0009	0.5076	0.0282	0.1748	0.0040	0.5914*	0.0360
	(0.3048)		(0.5097)		(0.3172)		(0.3240)		(0.3136)	

Significant at * – .10, ** – .05 and *** – .01 level. Elasticities calculated at the means. Numbers presented in brackets are the corresponding standard errors.

The signs on the coefficients of operating expense to operating income, and operating income per unit of labour do accord with expectations, but only for specifications 1 and 2. Whilst these measures are positively related to a higher level of efficiency with a profit-based, physical production approach, they appear to bear no relation to the calculated efficiency of credit unions specified with cooperative, not-for-profit strategies. This would tend to suggest that such financial ratios are inappropriate for ranking the productive performance of credit unions.

Finally, tests of the significance of the geographic and institutional dummies are undertaken. In the case of specifications 1 and 3, the null hypothesis of the joint insignificance of the geographic dummies is rejected at the .01 level using a Wald chi-square statistic, whilst that for specification 5 is rejected at the .05 level. The results suggest that even when an individual credit union's financial characteristics are accounted for using ratios, differences in efficiency can still be partially explained by location. When the coefficient on the institutional dummy variable is examined the results suggest that industrial-based credit unions are less efficient when efficiency is measured on the basis of specification 1, but more efficient when assessed on the basis of specification 5.

5. Concluding remarks

A number of points emerge from the present study. First, the overall technical efficiency measures indicate that for the average Australian credit union a proportional reduction of inputs to 97 to 72 percent of the current level is indicated, depending on the behavioural assumptions employed. Further, the results also suggest that inefficiencies derived from an incorrect scale of operations seems to be an important issue for credit unions. In a simple profit maximising, production-based approach, only 10 percent of credit unions were scale efficient.

Second, comparisons between the rankings provided by financial ratios and DEA measures indicate fundamental limitations in the applicability of the former to cooperative financial institutions. Of the indicators analysed, the ratios of expenses to assets and income to expenses identify highly performing credit unions in simple profit-based, production-orientated, input/output specifications, but not in those with more diverse objectives. Moreover, the ratios of income to labour or branch cannot consistently identify efficient outcomes in any specification. Put simply, the performance rankings provided by measures similar to those found in the commercial banking sector will not adequately reflect the inherently complex, and often contradictory, multiple-input, multiple-output framework in which credit unions operate. This is somewhat less alarming than the fact that a number of studies have found inconsistencies between financial ratios and efficiency measures in 'for-profit' institutions as well.

Finally, whilst there is an association between financial and efficiency performance measures, the strength and direction of this association is likely to vary with the choice of *a priori* behavioural assumptions. Thus, efficiency measures form an important supplement to traditional financial performance measures, but should be used with care. One obvious limitation is that of commonly-used financial ratios are inherently profit-orientated and production-based: a matter of some concern in a not-for-profit, cooperative setting. However, the results also show that efficiency measures themselves are extremely sensitive to residual differences in geographic and institutional characteristics, and variation in specifying inputs and outputs. The latter point highlights the need for rigorous *a priori* reasoning in specifying inputs and outputs when using the DEA approach to efficiency measurement.

REFERENCES

ALI, A.I. and SEIFORD, L.M., 1993, The mathematical programming approach to efficiency analysis. In HO Fried, CAK Lovell and SS Schmidt, eds., *The Measurement of Productive Efficiency,* Oxford University Press, New York.

ATHANASSOPOULOS, A.D. and BALLANTINE, J.A. 1995, Ratio and frontier analysis for assessing corporate performance: Evidence from the grocery industry in the UK, *Journal of the Operational Research Society*, 427–440.

BANKER, R.D. CHARNES, A. and COOPER, W.W., 1984, Some models for estimating technical and scale inefficiencies in data envelopment analysis, *Management Science,* 1078–1092.

BERGER, A.N. and HUMPHREY, D.B., 1991, The dominance of inefficiencies over scale and product mix economies in banking, *Journal of Monetary Economics,* 117–148.

CHARNES, A. COOPER, W.W. and RHODES, E., 1978, Measuring the efficiency of decision making units, *European Journal of Operational Research*, 429–444.

CHARNES, A. COOPER, W.W. LEWIN, A.Y. and SEIFORD, L.M. 1993, eds.*, Data Envelopment Analysis: Theory, Methodology and Applications*, Kluwer, Boston.

COLWELL, R.J. and DAVIS, E.P., 1992, Output and productivity in banking, *Scandinavian Journal of Economics*, 111–129.

CUBBIN, J. and ZAMANI, H., 1996, A comparison of performance indicators for training and enterprise councils in the UK, *Annals of Public and Cooperative Economics,* 603–632.

DRAKE, L. and WEYMAN-JONES, T.G., 1996, Productive and allocative inefficiencies in U.K. building societies: A comparison of non-parametric and stochastic frontier techniques, *The Manchester School*, 22–37.

ELYASIANI, E. and MEHDIAN, S.M., 1990, A nonparametric approach to measurement of efficiency and technological change: The case of large US commercial banks, *Journal of Financial Services Research*, 157–168.

ELYASIANI, E. and MEHDIAN, S.M., 1994, An empirical test of association between production and financial performance: The case of the commercial banking industry, *Applied Financial Economics*, 55–59.

FARRELL, M.J., 1957, The measurement of productive efficiency. *Journal of the Royal Statistical Society*, 253–289.

FAVERO, C.A. and PAPI, L., 1995, Technical efficiency and scale efficiency in the Italian banking sector: A non–parametric approach, *Applied Economics*, 385–395.

FRIED, H.O. LOVELL, C.A.K. and VANDEN EEKAUT, P., 1993, Evaluating the performance of US credit unions, *Journal of Banking and Finance*, 251–265.

FRIED, H.O. LOVELL, C.A.K. and TURNER, J.A., 1996, An analysis of the performance of university-affiliated credit unions, *Computers and Operations Research*, 375–384.

PIESSE, J. and TOWNSEND, R., 1995., The measurement of productive efficiency in UK building societies, *Applied Financial Economics*, 397–407.

SEIFORD, L.M. and THRALL, R.M., 1990, Recent developments in DEA: The mathematical approach to frontier analysis, *Journal of Econometrics*, 7–38.

SMITH, P., 1990, Data envelopment analysis applied to financial statements, *Omega, International Journal of Management Science*, 131–138.

THANASSOULIS, E. BOUSSOFIANE, A. and DYSON, R.G., 1996, A comparison of data envelopment analysis and ratio analysis as tools for performance measurement, *Omega, International Journal of Management Science*, 229–244.

YEH, Q-J., 1996, The application of data envelopment analysis in conjunction with financial ratios for bank performance evaluation, *Journal of the Operational Research Society*, 980–988.