Worthington, Andrew C. (2001) *Efficiency in Pre-Merger and Post-Merger Non-Bank Financial Institutions.* Managerial and Decision Economics, 22(8). pp. 439-452.

Efficiency in Pre-Merger and Post-Merger Non-Bank Financial Institutions

Andrew C. Worthington*

School of Economics and Finance, Queensland University of Technology, Queensland, Australia

A two-part process is employed to analyse the role of efficiency in merger and acquisition (M&A) activity in Australian credit unions during the period 1993 to 1997. The measures of efficiency are derived using the nonparametric technique of data envelopment analysis. The first part uses panel data in the probit model to relate pure technical efficiency, along with other managerial, regulatory and financial factors, to the probability of merger activity, either as an acquiring or acquired entity. The results indicate that loan portfolio diversification, management ability, earnings and asset size are a significant influence on the probability of acquisition, though the primary determinant of being acquired is smaller asset size. The second part uses a tobit model adapted to a panel framework to analyse post-merger efficiency. Mergers appear to have improved both pure technical efficiency and scale efficiency in the credit union industry.

INTRODUCTION

Worthington, Andrew (2001) Efficiency in Pre-Merger and Post-Merger Non-Bank Financial Institutions. *Managerial and Decision Economics* 22:pp. 439-452.

During the last two decades, sweeping changes to the restrictions governing deposit-taking institutions (DTI) around the globe have been made. Financial service providers who previously operated within well-defined, regulatory sub-sectors have been forced to adapt to newly deregulated environments. And to some extent, the most discernible response by the financial services industry to the concomitant increase in competition has been an increase in merger and acquisition (M&A) activity. In turn, the wave of M&As has placed an emphasis on the efficiency implications of DTI mergers. Berger *et al*. (1993, p. 232) justifies the interest of policy-makers and other concerned parties in this process as follows:

* Correspondence to: School of Economics and Finance, Queensland University of Technology, GPO Box 2434, Brisbane, QLD 4001, Australia. Tel.: +61 7 3864 2658; fax.: +61 7 3864 1500; email: a.worthington@qut.edu.au

> If these mergers are successful in improving banking industry efficiency, substantial benefits may accrue to the customers and claimholders of these banks, and the level of competition within the banking industry may be considerably increased. Moreover, the efficiency effect of mergers constitutes an important policy question on its own, since merger applicants often cite prospective efficiency benefits as a justification for merger approval.

However, when examining existing research in the area of financial institution merger efficiencies, a number of salient points emerge. First, while bank merger efficiencies have been extensively studied, primarily in the context of US financial institutions [see, for instance, Rhoades (1993), Shaffer (1993), Elyasiani *et al*. (1994) and Grabowski *et al*. (1995)], relatively little attention has been paid to measuring the post-merger efficiency of non-bank financial institutions or banks outside the US. Berger *et al*. (1999, p. 180) use these shortcomings to direct future research in this area:

> Most of the empirical research on financial services consolidation has focused on US banking organisations, and much of this has used data from the 1980s or early 1990s that may not well represent the consolidation of the future. We suggest that future studies focus on recent data from many nations [and] …should put additional emphasis on the effects of M&As of non-bank financial institutions.

Second, even when studies have concerned themselves with this area [for exceptions see Thompson (1997), Fried *et al*. (1999) and Garden and Ralston (1999)], little is known about the pattern of efficiency in pre-merger firms and whether these characteristics are taken into account in the merger process. This is despite the fact that the pattern of financial institution mergers is acknowledged to reflect an industry-wide drive for greater operational economies, and the application of regulatory incentives to promote efficiency and stability within the financial system. Third, Berger *et al*. (1993, p. 235) has also called for further research to determine the factors that predict efficiency gains or losses: “for policy purposes, it is important to know the factors that predict efficiency benefits, given that market participants often claim such benefits when applying for regulatory approval”. Finally, Berger *et al*. (1999, p. 181) has also directed the form future empirical work in this area should take: “future research should more often employ dynamic analysis methods that evaluate the consequences of consolidation by comparing the behaviour of financial institutions before and after M&As or by comparing the behaviour of recently consolidated institutions with other institutions”. It is with these considerations in mind that the present study is undertaken.

The selection of Australian credit unions for this purpose is appropriate for a number of reasons. First, in the period following the major Australian Financial System (Campbell)

Inquiry (1981) recommendations, credit unions, along with all other DTIs, were forced to adapt to a newly deregulated environment. As discussed, these invariably increased the pace of M&A activity. However, the pressures for consolidation have been particularly pronounced in the Australian credit union industry.[1] In evidence, mergers account almost entirely for the twenty-three percent decline in the number of individual credit unions operating over the period 1992 to 1997. There is currently no single study concerning the pattern of both pre-merger and post-merger efficiency in these institutions.

Second, existing empirical evidence suggests that the motives for mergers in co-operative deposit-taking institutions vary substantially from those found in, say, commercial banks. One aspect of this process is that an individual member can acquire only one vote regardless of the value of funds committed, and that credit unions cannot acquire shares in another. Hostile acquisition is therefore difficult, if not impossible, to achieve. Accordingly, there is the suggestion that structural change in co-operative financial services is essentially restricted to 'friendly' mergers, and that there is a large degree of acquiescence by regulatory authorities in this matter. Furthermore, it is also the case that liquidation of Australian credit unions has been extremely rare, and it is widely understood that the exit of a credit union in financial distress is likely to occur through merger rather than liquidation (Brown *et al*., 1999). The impact of these differences on non-bank financial institution merger activity and post-merger efficiency gains remains as yet unquantified.

Third, the regulatory environment within which Australian co-operative deposit-taking institutions operate appears to have played an indirect role in fostering merger activity. Beginning with the *Australian Financial Institutions Act 1992* and later an amended *Banking Act 1959* [as recommended in the Financial System (Wallis Committee) (1997) Inquiry] all banks, building societies and credit unions are now regulated by the Australian Prudential Regulation Authority (APRA) as a single class of 'authorised deposit-taking institutions'. It has, for example, been suggested that the prudential standards on liquidity, capital and lending in credit unions have highlighted merger as a means of increasing capital base and improving efficiency (Davis, 1994).

It is important to note, however, that regulatory control on deposit-taking institution merger activity in Australia is almost always indirect. 'Forced' mergers are virtually unknown. Though APRA may issue a direction to an institution that fails to comply with a prudential standard, and this could feasibly result in the appointment of a statutory manager who then could arrange a merger, these direction powers are rarely used and then only as a

last resort (APRA, 2000). Nevertheless, while conceivably all credit union mergers in Australia are 'unassisted' they, as noted by Fried *et al*. (1999, p. 372) in the US context, "…typically run the gamut from 'encouraged' to completely voluntary".

Finally, while it is generally accepted that a credit union's overriding objective is maximisation of member benefits, there is evidence that the objectives of Australian credit unions have increasingly been shaped by management towards profit-maximisation. The most obvious reason is that decisions by management with respect to member services are made in the context of a highly competitive financial sector (Garden and Ralston, 1999). Moreover, there is the suggestion that this reorientation of credit union objectives has facilitated the merger process in recent years. However, in spite of the erosion of the traditional objectives of credit unions, there is still an emphasis on the common bond or affinity that defines membership. For example, credit unions in Australia are restricted to three categories: namely, industrial (employee) groups; community-based (geographic) groups; and parish (religious) groups. Although there has been a considerable weakening of these bonds, it also suggest that more immediate concerns in finding a merger partner may be consideration of consistency of purpose and geographic location, as against more commercial motives. There is a compelling case for the analysis of such factors in the Australian institutional milieu.

Accordingly, the analysis of efficiency as a motive for and outcome of merger activity in cooperative deposit-taking institutions is likely to involve the complex interaction of a large number of factors. Furthermore, it is likely that these motives have changed substantially during the recent program of financial reform. Three characterisations of the merger process are likely. One possible characterisation is that the merger process in Australia reflects the reorientation of credit unions services towards profit-maximisation, and is therefore predominately driven by managerial objectives. Thompson (1997, p. 39) has argued that this mechanism is comparable to that provided by the market for corporate control in the joint stock sector, which "works to eliminate underperforming mutuals and transfer their assets to other societies within the sector".

A second characterisation is that the merger process reflects direct intervention by regulators to promote efficiency and stability within the financial system. Moreover, regulatory constraints placed upon credit unions may highlight mergers as a means of increasing operative efficiency in an increasingly competitive financial services industry.[2] A final characterisation is that notwithstanding the commercial and regulatory imperatives discussed earlier, the notion of a bond of association may exert a strong influence on merger

activity, and thereby on post-merger efficiency gains. A careful analysis of these divergent forces should therefore add to our knowledge about the factors determining the pattern of structural change in Australia financial services, and provide at least some idea of the effectiveness of recent microeconomic reform, especially in regard to some of the smaller deposit-taking institutions.

In this paper an attempt is made to examine efficiency both as a determinant and outcome of merger activity in Australian credit unions. The paper itself is divided into three main sections. The second section deals with the specification of those variables posited to influence the recent pattern of post-deregulation mergers and with the derivation of measures of pre-merger and post-merger efficiency. The third section presents the empirical results of the analysis. The paper ends with some brief concluding remarks in the final section.

EMPIRICAL METHODOLOGY

The data used in this study consists of annual observations of Australian credit unions. All data is sourced from the Australian Prudential Regulation Authority (APRA) and its predecessor, the Australian Financial Institutions Commission (AFIC). The data is from financial statements submitted by credit unions to APRA for the purpose of prudential supervision. For the aim of analysing pre-merger and post-merger efficiency in Australian credit unions the available sample is divided into two periods. These are: (i) a pre-merger period, when the determinants of M&A activity are examined, and (ii) a post-merger period, when the efficiency outcomes of these mergers are examined. The pre-merger time period is taken as the financial years 1993 to 1995, and the post-merger time-period is 1996 to 1997.[3]

Of course, the total number of credit unions in operation and the number of merging credit unions vary over these periods. For example, of the 323 credit unions in operation in 1993, 17 credit unions ‘acquired’ 19 credit unions during 1994, leaving 304 institutions at the end of the year. In 1995, 14 credit unions ‘acquired’ 14 other credit unions leaving 290 credit unions. Finally, 7 credit unions merged in 1996 and 12 in 1997. A more extensive set of time-series data would be more valuable. Unfortunately, a national framework for prudential supervision of non-bank deposit-taking institutions (along with the requisite database) was only established with the creation of AFIC in 1992.

Two separate approaches are taken to analyse the pattern of efficiency in pre-merger and post-merger credit unions. Both are regression-based. First, probit analysis is used to

determine the impact of efficiency, as a proxy for managerial ability, on the probability of M&A in the period 1993 to 1995. Secondly, tobit analysis is used in the period 1996 to 1997 to measure the impact of merger on the level of efficiency.[4] To start with, an unbalanced panel data probit model is used to analyse the factors that influence merger activity in credit unions. The advantage of this form is that it allows for both cross-sectional and time-series variation in the determinants of mergers and allows the use of data where the number of cross-sections vary from year-to-year. Firm-level identifiers link cross-sections in different years. In any given year, a credit union has two possible outcomes: (i) merge with another credit union, either as an 'acquiring' or 'acquired' party; and (ii) maintain the status quo. Since we would expect the subsets of merging credit unions to have distinct characteristics, two separate models are estimated, one for 'acquiring' credit unions and one for 'acquired' credit unions. 'Acquiring' credit unions are defined as those that subsequently incorporated another credit union's assets, while 'acquired' credit unions are subsequently incorporated into another credit union. Hence the following model is estimated:

$$\begin{aligned} y_{it+1} &= \beta_*^{'} x_{it} + u_{it} + v_{it} \\ y_{it+1} &= 1 \text{ if } y_{it}^{*} > 0 \text{ and } 0 \text{ otherwise} \end{aligned} \tag{1}$$

where the probability of occurrence of the dependent variable (which takes the value of unity if the *i*th credit union acquired or was acquired in the subsequent year, $t + 1$, and zero otherwise), is thought to depend on a set of financial, managerial and regulatory factors x in the current year, t, β is a set of parameters to be estimated, $\beta = \beta / \sigma_v$ Var$[u_{it} + v_{it}]$ = Var$[\varepsilon_{it}] \sim N[0, \sigma^2]$, Corr$[\varepsilon_{it} + \varepsilon_{is}] = \rho = \sigma^2_u / (\sigma^2_u + \sigma^2_v)$, and $i = 1,...,N$ and $t = 1,...,T$.

The explanatory variables contained in x are defined in Table 1. Descriptive statistics are provided for acquiring and acquired credit unions and for credit unions that neither acquired nor were acquired in the period. The first set of variables represent various aspects of firm performance and are structured in accordance with a CAMEL (capital structure, asset quality, management ability, earnings and liquidity) classification system.[5] Each type of ratio provides a means of measuring a particular aspect of credit union performance or risk, with the exception of management ability. Normally, assessed by regulators on a range of non-quantitative criteria, management ability in this instance is proxied using nonparametric measures of efficiency. Descriptive statistics for the variables other than management ability (*CAP* to *AST*) are in the bottom part of Table 1, while the inputs and outputs used to provide

the measure of efficiency as a proxy for management ability (*PTE*) are in the top part (*PL* to *NIX*). The derivation of *PTE* is discussed following the other measures of credit union performance and risk.

Table 1. Inputs, outputs and explanatory variable descriptive statistics (1993–1995)

Variable	Description	Non-merging credit unions		Acquiring credit unions		Acquired credit unions	
		Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
PL	Personal loans	14557.40	25749.59	31404.75	33508.47	2770.19	5449.01
CL	Commercial loans	1017.44	3011.93	867.60	1636.15	159.73	551.45
RL	Residential loans	14270.59	29748.03	25836.54	25677.49	2517.57	8310.64
INV	Investments	7729.51	14311.22	14195.45	13677.27	1379.71	2814.29
IY	Interest income	3529.37	6109.03	7335.55	7657.14	650.25	1487.98
NIY	Non-interest income	326.91	809.39	541.84	609.23	54.97	156.07
PHY	Physical capital	903.52	2182.23	1635.37	2445.66	164.15	507.06
AC	At-call deposits	15686.28	32478.52	28496.09	30211.88	2708.02	7028.06
NW	Notice-of-withdrawal deposits	2243.24	8511.59	3149.21	5106.38	373.51	1180.75
FT	Fixed term deposits	18011.55	33378.68	36888.23	36740.90	3173.25	7295.32
IX	Interest expense	1710.86	3112.33	3414.38	3540.58	275.17	591.31
NIX	Non-interest expense	1750.49	3016.19	3720.62	3813.95	401.94	998.64
CAP	Reserves/Total assets	0.0588	0.0476	0.0480	0.0321	0.0725	0.0462
DDX	Doubtful debts expense/Total loans	0.0039	0.0084	0.0171	0.0111	0.0447	0.0539
HRF	Herfindahl index of loan concentration	0.6880	0.2233	0.5513	0.1031	0.9027	0.1866
PTE	Pure technical efficiency	0.9115	0.1112	0.9848	0.0315	0.8895	0.0464
NIL	Net interest income/Total loans	0.0577	0.1578	0.0680	0.0173	0.0782	0.0416
TEX	Total expense/Total income	0.0637	0.0918	0.0642	0.0355	0.0457	0.0735
LIQ	Prime liquid assets/Total assets	0.2317	0.1304	0.1756	0.0588	0.2969	0.1450
CDP	Call deposits/Total deposits	0.4776	0.2035	0.4218	0.1217	0.6217	0.2688
AST	Total assets (in logarithms)	1.0243	0.8237	1.6879	0.4639	0.1153	0.8101

Notes: Inputs and outputs in thousands of Australian dollars. Distribution of credit unions by associational bond (1993, 1994 and 1995): Community-based (COM) – 117, 110, 104; Industrial-based – 192, 183, 178; Parish-based – 15, 11, 8. The means and standard deviations are calculated using pooled data.

The first set of variables discussed relate to capital structure, asset quality, earnings and liquidity as determinants of M&A. The first variable relates to the role of capital structure (*CAP*) in determining the likelihood of merger or acquisition in credit unions. Capital is of particular concern in depository financial institutions of this type because of their low net worth and highly leveraged nature, which creates a potential for failure should there be a sudden withdrawal of deposits. The measure of capital within each institution is defined as the ratio of reserves (including permanent share capital, asset revaluations and retained earnings) to total assets. All other things being equal, an acquired (acquiring) credit union should have a

relatively lower (higher) level of capital (Berger *et al*., 1999). A negative coefficient is hypothesised for acquired credit unions and a positive coefficient for acquiring credit unions.

The second variable relates to the asset management activities of each credit union. Asset quality measures are concerned with assessing the default or credit risk of the loan portfolio, as well as the allocation of the asset portfolio between liquid investments and loans. One measure used is the ratio of doubtful debts expense to total loans (*DDX*). The *ex ante* sign on this coefficient is thought to be positive (negative) for acquired (acquiring) credit unions, reflecting in part the extent of asset diversification and the impact of asset risk on merger activity. An additional variable is included to measure the extent of asset diversification in the loan portfolio: namely, a Herfindahl index of loan concentration (*HRF*). This measure takes a value between zero and unity, with a higher value indicating a relatively less-diversified loan portfolio. Berger *et al*. (1999) provide evidence that acquiring banks bid more for targets when the M&A would lead to significant diversification gains and that diversifying M&As may also improve efficiency through expanding the skill sets of managers. Given this focus on diversification, it is posited that a credit union with a relatively undiversified (diversified) loan portfolio will be more (less) likely to be acquired and less (more) likely to acquire another institution.

The next two variables in Table 1 relate to credit union profitability; namely, the ratio of net interest income to total loans (*NIL*) and the ratio of total expense to total income (*TEX*). The second measure is particularly pertinent in that it indicates the operational risk of the institution, that is, the possibility that the costs of operating the institution will exceed its revenues, thereby depleting equity capital. A negative relationship is thought to exist between profitability and acquired credit unions and a positive relationship for acquiring credit unions.

The sixth variable is a measure of liquidity, defined as the ratio of prime liquid assets to total assets (*LIQ*). Insufficient liquidity to meet demand for deposit withdrawals is identified as a key source of depository financial institution risk, and thereby the likelihood that merger activity will be used as a means of managing such risk. The final variable is also a measure of liquidity; that is, the ratio of call deposits to total deposits (*CDP*). Potential calls on demand deposits expose depository institutions to sudden liquidity crises, call deposits to total deposits provides a measure of this exposure. The variables used to represent various aspects of credit union performance are comparable to those employed by Thompson (1997) in an analysis of mergers in UK building societies, and Ralston (1998) in an Australian credit union financial distress model. For both measures of liquidity, a negative (positive) coefficient is

thought to exist *ex ante* for acquired (acquiring) institutions. Lastly, a variable indicating the total assets (*AST*) of each credit union (in logs) is also included. Abundant evidence already exists that a significant determinant of M&A activity in financial institutions is size. A positive (negative) coefficient is hypothesised for acquiring (acquired) credit unions.

In addition to these quantitative variables, a qualitative variable is also included in the regression. This relates to the associational bond under which each credit union is created: that is, community, industrial or parish-based. All other things being equal, a community-based credit union (*COM*) will have a more diversified membership than an industrial or parish-based one, and may have less resistance by its members to a merger. While these institutional divisions are rapidly eroding, the usual implication is that the prospects for finding an appropriate merger partner are higher for community-based credit unions. The *ex ante* sign on the dummy variable is thought to be positive for both acquiring and acquired credit unions.

The final variable included in the regression relates to management ability vis-à-vis efficiency. The method used to measure efficiency in these credit unions is based upon data envelopment analysis (DEA), a mathematical programming approach to frontier estimation pioneered in Charnes *et al*. (1978) and extended in Banker *et al*., (1984).[6] Suitable introductions to DEA may be found in Coelli *et al*. (1997) and Cooper *et al*. (2000). Measuring efficiency in this manner is consistent with both the recent literature associated with the efficiency analysis of deposit-taking institutions in general, including Elyasiani *et al*., (1994), Favero and Papi (1995), Miller and Noulas (1996), and with a large number of past empirical approaches to efficiency measurement in non-bank financial institutions, notably Piesse and Townsend (1995), Drake and Weyman-Jones (1996) and Worthington (1998; 1999; 2000). Berger and Humphrey (1997) provide a comprehensive survey of the various approaches to efficiency measurement in financial institutions.

The computational procedure used to implement the DEA approach to efficiency measurement is presented briefly as follows. Consider N credit unions each producing M different outputs using K different inputs in a particular time period. The $K\times N$ input matrix, X, and the $M\times N$ output matrix, Y, represent the data of all N credit unions, while for the individual credit union these are represented by the vectors x_i and y_i. The efficiency of each credit union can be determined from the solution to the following linear program:

$$\begin{aligned} \min_{\theta,\lambda} \theta \\ \text{s.t.} - y_i + Y\lambda \geq 0 \\ \theta x_i - X\lambda \geq 0 \\ \lambda \geq 0 \end{aligned} \qquad (2)$$

where y_i is the vector of outputs produced by the ith credit union, x_i is the vector of inputs used by the ith credit union, i runs from 1 to N, and j equals 1, 2, ..., N, θ is a scalar and λ is a $N \times 1$ vector of constants. The value of θ will be the technical efficiency score for a particular credit union. It will satisfy $\theta \leq 1$, with a value of 1 indicating a point on the frontier, and hence a technically efficient credit union. The value of $\theta \leq 1$ identifies the amount of any inefficiencies that may be present.

The model specified in (2) has an assumption of constant returns-to-scale and is only appropriate where all credit unions are operating at an optimal scale. Where this assumption does not hold, scale effects will confound the measures of technical efficiency. Generally, regulatory, geographical and institutional constraints imply that most credit unions are not operating at an optimal scale. Following Banker *et al*. (1984) the linear programming problem can be modified to account for variable returns-to-scale (that is, measures of technical efficiency without scale efficiency effects) by adding the convexity constraint $N1'\lambda = 1$ to (2). The measure of technical efficiency obtained without the convexity constraint (that is, under an assumption of constant returns-to-scale) is referred to as overall technical efficiency. The measure obtained including the convexity constraint (that is, assuming variable returns-to-scale) is known as pure technical efficiency (*PTE*). Dividing overall technical efficiency by pure technical efficiency yields a measure of scale efficiency (*SCE*).

In this program, emphasis is placed on the equiproportionate reduction of inputs. An input orientation is adopted since it is assumed that capital adequacy and liquidity requirements are likely to restrict the level of output in any time period. Hence, a suitable behavioural objective for these institutions would be that of input minimisation, rather than output maximisation. The input measures thus provided can then detect failures to minimise inputs resulting from discretionary power and incomplete monitoring, and thereby provide an indication of possible gains from exploiting technical efficiencies. Other efficiency studies that employ an input-orientated approach include Worthington's (1998) analysis of Australian credit unions and Drake and Weyman-Jones' (1996) study of UK building societies.

The inputs and outputs employed in the DEA approach are detailed in the upper part of Table 1 (in thousands of Australian dollars), and follow the intermediation approach to

modelling financial institution behaviour. In this approach credit unions combine physical capital (*PHY*), at call deposits (*AC*), notice-of-withdrawal deposits (*NW*) and fixed term deposits (*FT*), along with interest (*IX*) and non-interest expenses (*NIX*), to produce personal loans (*PL*), commercial loans (*CL*) residential loans (*RL*), investments (*INV*), interest (*IY*) and non-interest income (*NIY*). In terms of specific studies, the approach is most consistent with the value-added intermediation approach used by Berg *et al*. (1993), Favero and Papi (1995) and Fried *et al*. (1996). A single variable is subsequently defined for the probit analysis in (1). This is an index measure of pure technical efficiency (*PTE*). Pure technical efficiency (*PTE*) is used since overall technical efficiency includes scale efficiency, and therefore is likely to reflect circumstances that are largely beyond managerial control. All other things being equal, an acquired (acquiring) credit union is expected to be relatively less (more) pure technically efficient than an acquiring (acquired) credit union. Put differently, managerial ability is thought to be higher in acquiring credit unions than acquired credit unions. A negative (positive) coefficient is expected for acquired (acquiring) credit unions.

The second part of the procedure used to analyse efficiency in Australian credit unions involves the specification of a set of explanatory variables presumed to account for post-merger efficiency in the period 1996 to 1997. Summary statistics for these variables are detailed in Table 2. Once again, the inputs and outputs need for the DEA measures of efficiency are in the upper portion of the table and the explanatory variables are in the bottom part. Also included are descriptive statistics relating to the measures of pure technical and scale efficiency specified as dependent variables. An unbalanced panel data tobit model is used to analyse the factors that influence post-merger efficiency in co-operative deposit-taking institutions as follows:

$$\begin{aligned} y_{it} &= \beta' x_{it} + u_{it} + v_{it} \\ y_{it} &= 1 \text{ if } y^*_{it} \geq 1 \\ y_{it} &= y^*_{it} \text{ if } y^*_{it} < 1 \end{aligned} \qquad (3)$$

where y is an efficiency score (either pure technical or scale efficiency) for the ith credit union in the tth time-period, x is a set of explanatory variables posited to explain the presence of efficiency in credit unions, β are parameters to be estimated, $\text{Var}[u_{it} + v_{it}] = \sigma^2_u + \sigma^2_v = \text{Var}[\varepsilon_{it}] \sim N[0, \sigma^2]$ and $i = 1,...,N$ and $t = 1,...,T$. In this approach, the efficiency of each credit union is expected to depend on a set of institutional characteristics and financial measures that

characterise its operations. Aly *et al*. (1990), Drake and Weyman-Jones (1992), and Fried, Lovell and Vanden Eeckaut (1993), amongst others, have also used nonparametric techniques to measure efficiency in financial institutions, followed by parametric techniques to explain variation in efficiency.

Table 2 details the inputs and outputs (in thousands of dollars) used to obtain measures of pure technical (*PTE*) and scale (*SCE*) efficiency over the sample period. The approach used to calculate these measures is identical to the measures of efficiency derived in the pre-merger period. Table 2 also includes details on the explanatory variables that relate to firm-specific operational characteristics. The first variable, the proportion of non-interest income to interest plus non-interest income (*NNT*), relates to an important aspect of credit union financial management. This measure is considered especially important given that one focus of deregulation was that "the pricing of banking services ... reflect more closely the user pays principle, thus creating incentives for efficiency improvements" (Financial System Inquiry 1997: 610). However, given the fact that their underlying commitments may not be related to specific balance sheet magnitudes, it is somewhat difficult to postulate the relationship between non-interest revenue sources and firm efficiency. A positive coefficient is hypothesised when efficiency is regressed upon this measure.

The next two variables are intended to measure whether efforts by credit unions to improve the level of post-merger competitiveness and dynamic efficiency are reflected in relatively higher levels of efficiency. These are the proportion of total expenses derived from expenditures on information technology (*INF*) and the proportion of total expenses associated with expenditures on marketing and promotion (*MKT*). All other things being equal, it is hypothesised that credit unions that have invested heavily in information technology and product development should be relatively more efficient in the production of the dollar outputs of loans and other financial assets: positive coefficients are hypothesised on both counts.

Two variables are also used to explain how credit union efficiency relates to the composition and performance of the loan portfolio: (i) the proportion of residential and property loans in the total portfolio (*REL*) and (ii) the proportion of commercial and business loans in the total loan portfolio (*COL*). One argument here is that a clear 'market-orientation' in regards to commercial and residential loans may be associated with a relatively more efficient credit union (Mester, 1993). In addition, we could also expect that credit unions which are exposed to the strong competitive forces in residential and commercial loan

markets are obliged to undertake programs aimed at enhancing efficiency. The *ex ante* signs on the coefficients for commercial and residential loans are thought to be positive.

Table 2. Inputs, outputs, dependent and explanatory variable descriptive statistics (1996–1997)

		Non-merged credit unions		Merged credit unions	
Variable	Description	Mean	Standard deviation	Mean	Standard deviation
PL	Personal loans	17762.94	32453.89	43167.06	44718.54
CL	Commercial loans	1343.14	3747.85	2315.84	2379.63
RL	Residential loans	21901.74	50146.64	39302.72	36866.71
INV	Investments	9268.36	16888.32	19511.43	19818.35
IY	Interest income	4628.66	8771.63	10202.31	10349.14
NIY	Non-interest income	513.62	1310.28	1027.98	1070.56
PHY	Physical capital	1122.63	2904.46	2093.58	2377.80
AC	At-call deposits	21337.28	44817.31	44038.46	43320.58
FT	Fixed term deposits	24024.60	46161.52	49727.32	44620.03
IX	Interest expense	2215.51	4501.59	4531.25	4382.70
NIX	Non-interest expense	2394.58	4480.38	5637.72	5899.36
PTE	Pure technical efficiency	0.9481	0.0787	0.9648	0.0417
SCE	Scale efficiency	0.8977	0.0982	0.9338	0.0769
NNT	Non-interest income/Total income	0.0706	0.0928	0.0896	0.0460
INF	Information expenses/Total expenses	0.0453	0.0327	0.0428	0.0153
MKT	Marketing expenses/Total expenses	0.0168	0.0144	0.0246	0.0112
REL	Residential loans/Total loans	0.3619	0.2532	0.4501	0.1438
COL	Commercial loans/Total loans	0.0271	0.0436	0.0309	0.0356
MEM	Number of members	12548.21	19385.81	10255.71	15501.45

Notes: Inputs and outputs in thousands of Australian dollars. PTE and SCE are DEA-based measures of efficiency specified as explanatory variables in the second-stage regression. The means and standard deviations are calculated using pooled data.

The next two variables relate to additional non-financial characteristics of Australian credit unions. The first variable is intended to account for the effect of the number of credit union members (*MEM*) on efficiency. All other things being equal, a credit union with a large number of members will have a more diversified membership than one with a smaller membership. Generally this would imply that the prospects for attaining an efficient scale of operations are higher (Fried *et al.*, 1993). Similarly, credit unions with a large number of members are more likely to actively engage in the technological innovation associated with deregulation. Both hypotheses suggest a positive coefficient for credit union membership when used as an explanatory variable for technical and scale efficiency. Alternatively, credit

unions with a small (and presumably homogeneous and concentrated) membership may be able to direct greater effort at enhancing technical efficiency and technological innovation than those credit unions with a larger (more heterogeneous and widely spread) membership. Ferrier and Lovell (1990) and Fried *et al*. (1996), amongst others, have argued that the interaction between the number of members/accountholders and total deposits/loans is more important in determining efficiency than the absolute value of these variables. Thus, a low membership (with a high average deposit/loan account) may indicate *ex ante* a negative coefficient.

The final explanatory variable *MRG* is of primary interest to the study and indicates whether the credit union in question is a 'merged' institution: that is, it merged in the period 1993 to 1995. There is a small body of literature that examines merger-related efficiency gains in financial institutions. For example, Shaffer (1993) found little effect on efficiency resulting from scale effects, but identified that merger-related gains in technical efficiency were possible. Alternatively, Garden and Ralston (1999) found that a similar variable used to distinguish between efficiency changes in merged institutions was invariably insignificant. In a very different analysis, Fried *et al*. (1999) examined service provision in post-merger credit unions and compared it to service provision in pre-merger institutions. While that study does comment on post-merger outcomes, it is largely concerned with contrasting the changes in operating efficiencies between acquired and acquiring credit unions. No efficiency comparison is made with non-merging credit unions. Nevertheless, a positive coefficient is hypothesised when efficiency is regressed against a dummy variable indicating a merged institution.

EMPIRICAL RESULTS

In the previous section, we formulated models of the determinants of M&A activity in Australian credit unions over the period 1993 to 1995 and factors explaining the pattern of post-merger efficiency in these same institutions over the period 1996 to 1997. The set of explanatory variables in the first instance included a measure of pure technical efficiency as a proxy for managerial ability, and an identical measure plus a measure of scale efficiency were employed as dependent variables in the second instance. The results for the probit model used to examine the determinants of M&A activity in credit unions are presented in Table 3 and the estimated tobit regressions used to examine post-merger efficiency are detailed in Table 4.

Table 3. Determinants of credit union mergers (1993–1995)

	Acquiring credit unions				Acquired credit unions			
	Original specification		Refined specification		Original specification		Refined specification	
Variable	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
CONS.	-0.4164	2.1663	-0.6478	2.1364	-3.2790	1.9117	-0.1247	0.1701
CAP	-0.4434	2.1608			0.6128	1.6196		
DDX	5.5274	5.1129	4.5982	5.0022	0.1123	2.4802	-0.0603	0.0464
HRF	-1.6419**	0.6783	-1.7704***	0.6541	0.6145	0.5744	0.0551	0.0470
PTE	2.1316*	1.2330	2.1229*	1.2098	1.0202	1.8747	0.1932	0.1743
NIL	8.5772*	4.6550	8.3208*	4.5183	3.8241	2.6717	0.0602	0.0464
TEX	-2.6853**	1.0684	-2.7166***	1.0511	-1.1423	0.9241	-0.0946	0.0822
CDP	-0.2169	0.5968			0.1409	0.3840		
LIQ	-0.9725	1.1890			0.2197	0.6723		
AST	0.7055***	0.1955	0.7395***	0.1891	-0.4298***	0.1659	-0.0515***	0.0126
COM	0.0411	0.1728			0.0941	0.1770		
ρ	0.1830	0.2823	0.1943	0.2731	0.2733	0.52917	0.23603	0.50417
ln*L*	-143.5804		-144.0931		-147.8867		-148.2024	
ln*L*(0)	-164.4037		-164.4037		-176.5515		-176.5515	
LR	41.6466	0.0000	40.6212	0.0000	57.32946	0.0000	56.6981	0.0000

Notes: Asterisks indicate level of significance at the * .10, ** .05 and *** .01 level; ln*L* – log-likelihood; ln*L*(0) – restricted slopes log-likelihood; *LR* – likelihood ratio statistic; significance of estimate of ρ indicates evidence of random effects in data. In the unbalanced panel of data there are 917 observations (323 in 1993, 304 in 1994 and 290 in 1995).

The estimated coefficients and standard errors of the pre-merger parameters detailed in (1) are presented in Tables 3. Also included in Table 3 are statistics for likelihood ratio tests. The level of significance of ρ (p-value = 0.5168) indicates that the data is inconsistent with a random effects model and thus a basic probit model is employed. The results of two separate regression models for both acquiring and acquired credit unions are detailed. The first model includes all variables as specified. The second set of results re-estimates the model following tests of joint insignificance across the various dimensions of firm performance and risk. In the refined regressions for both acquiring and acquired credit unions, the variables *CAP*, *LIQ*, *CDP* and *COM* are tested for joint significance and are excluded from the model [$W = 0.31 \sim \chi^2_{(4)}$]. This result would appear to be sensible in that these variables are exogenously imposed via regulation and do not appear to vary significantly across acquired/acquiring and merged credit unions. Each of the remaining variables are tested on this basis, though fail to be excluded from the final specification. In the both the final and refined specification for

acquiring and acquired credit unions *LR* tests reject the null hypothesis that all the slope coefficients are jointly zero at the .01 level.

To start with, in the case of the probability of a credit union acquiring in 1993–1995, the coefficients relating to loan portfolio diversification (*HRF*), managerial ability (*PTE*), net interest income (*NIL*), total expense (*TEX*) and total assets (*AST*) are significant. The results indicate that the more pure technically efficient (*PTE*) a credit union (that is, the higher the level of managerial ability), and the higher the level of assets (*AST*) and interest earnings (*NIL*) the more likely it will acquire another credit union. Also, the less diversified the loan portfolio (*HRF*) and the higher the expense ratio (*TEX*) the less likely it will acquire. In terms of the signs on the estimated coefficients and the levels of significance the results of the refined specification for acquiring credit unions does not appear to vary from the full specification. Thompson (1997) likewise found that earnings and asset quality was significant in determining merger status in UK mutuals, while Ralston (1998) linked capital structure, asset quality and earnings with the likelihood of regulatory intervention vis-à-vis financial distress. Alternatively, Brown *et al*. (1999, p. 15) concluded on the basis of univariate statistics that merging credit unions "were as efficient as the industry as a whole but included a number of small credit unions".

In sharp contrast to the regression models for acquiring credit unions, both the full and refined specification for the acquired credit unions indicate that a single variable, smaller asset size (*AST*), is associated with an increased probability of being acquired. That is, while managerial ability, earnings, asset size and portfolio characteristics play a major role in the probability of a firm acquiring another, the primary determinant of a credit union being acquired is simply that it is smaller. Fried *et al*. (1999) also found that many factors associated with performance are likely to vary between acquiring and acquired credit unions. In terms of pure technical efficiency, there appears to be no significant difference between acquired and non-acquired credit unions, only that acquiring credit unions are generally more efficient than either group. These results then appear consistent with the surveyed evidence of Berger et al. (1999, p. 145) such that "…in a substantial proportion of M&As, a larger, more efficient institution tends to take over a smaller, less efficient institution, presumably at least in part to spread the expertise or operating policies and procedures of the more efficient institution over additional resources".

Table 4. Determinants of post-merger efficiency 1996–1997

	Pure technical efficiency		Scale efficiency	
	Coefficient	Standard error	Coefficient	Standard error
CONS.	0.9399***	0.0082	0.9449***	0.0101
MRG	0.1027***	0.0098	0.0457***	0.0121
NNT	0.0681**	0.0354	-0.0279	0.0434
INF	0.4258***	0.1004	0.2533**	0.1232
MKT	0.0435	0.2302	1.9793***	0.2825
REL	0.0426***	0.0136	0.0442***	0.0167
COL	0.1313*	0.0765	0.4437***	0.0939
MEM	0.2490	0.1654	0.2795	0.2030
ln*L*	668.5590		555.0293	
ln*L*(0)	645.5172		500.3015	
LR	6.7700	0.0000	17.0400	0.0000

Notes: Asterisks indicate level of significance at the * .10, ** .05 and *** .01 level; ln*L* – log-likelihood; ln*L*(0) – restricted slopes log-likelihood; *LR* – likelihood ratio statistic. In the unbalanced panel of data there are 554 observations (283 in 1996 and 271 in 1997).

The second part of the analysis involves regressing post-merger efficiency (pure technical and scale) on a set of explanatory variables for the period 1996 to 1997. Berger *et al*. (1999, p. 145) highlight the basic hypothesis from surveyed evidence, "large X-efficiency gains are possible if the best-practice banks merge and reform the practices of the least efficient banks". The results of this analysis are presented in Table 4. The first two columns are the normalised coefficients and standard errors of the regression of pure technical efficiency (*PTE*) scores on the set of financial and institutional characteristics presumed to account for efficiency differences. The second two columns repeat this information, though where the dependent variable is specified as scale efficiency (*SCE*).

Turning first to the model including pure technical efficiency, the ratio of non-interest income to total income (*NNT*) the proportion of total expenses made on information technology (*INF*), and the proportion of real estate (*REL*) and commercial (*COL*) loans are significant. The signs on these coefficients all conform to their hypothesised signs. A test of the null hypothesis that all slope coefficients are zero fails to be rejected at the 0.01 percent level using the likelihood ratio procedure ($LR = 6.77 \sim \chi^2_{(7)}$) and we may conclude that the analysis adequately models the pattern of efficiency in Australian credit unions. The suggestion is that credit unions with a higher proportion of real estate and commercial loans, a

higher level of non-interest income and higher expenditure on information technology are more pure technically efficient. However, the primary focus for this analysis is on the improvements in efficiency flowing from credit union mergers. The coefficient on the dummy variable for merged credit unions (*MRG*) is significant and positive, suggesting that pure technical efficiency is higher for these institutions than the industry as a whole in the post-merger period. Shaffer (1993), amongst other, also found that mergers provide technical efficiency gains, though in a study of Australian credit unions Garden and Ralston (1999) concluded that credit union mergers did not result in an increase in post-merger efficiency relative to other credit unions.

The next two columns in Table 4 present the results of a similar tobit model where scale efficiency is specified as the dependent variable. Once again the model is highly significant with a LR test of the restriction that all the slope coefficients are jointly zero rejected at the .01 level [LR = 17.04 ~ $\chi^2_{(7)}$]. Of the variables selected to proxy operational characteristics, the level of non-interest revenue (*NNT*), information technology (*INF*) and marketing and promotion expense (*MKT*), and real estate (*REL*) and commercial loans orientation (*COL*) are significant and conform to the hypothesised signs. These are substantially the same as that found in the regression on pure technical efficiency, though the estimated coefficient on marketing expense is not significant in that instance. The sign on merger status (*MRG*) is positive and significant at the .01 level, suggesting that merged credit unions are also more scale efficient. A Wald statistic [W = 9.03 ~ $\chi^2_{(2)}$] confirms the joint significance of the characteristics of the loan portfolio (*REL* and *COL*) on scale efficiency.

CONCLUSION

The present study uses discrete choice regression models to investigate the influence of financial, managerial and regulatory factors on the probability of a credit union merging during the period 1993–1995, and limited dependent variable techniques to examine whether efficiency has increased in these same institutions in the post-merger period 1996–1997. The current paper extends empirical work in this area in at least two ways. First, and as far as the author is aware, it represents the first attempt to test these purported factors in the Australian institutional milieu. While a select literature has examined the pattern of efficiency in merged credit unions, no paper to date has attempted to link efficiency and M&A activity in the first instance. This is an important advance and follows Berger's *et al*. (1999) suggestion that

future research should evaluate the consequences of consolidation by comparing the behaviour of financial institutions before and after M&As. Second, the paper also incorporates allowance for cross-sectional and time-series variation in M&As and efficiency effects through the use of panel data. This allows the more thorough investigation of these effects across the scope of an entire industry sub-group and across a sizeable number of time periods.

Interestingly, while the results suggest that the merger process is being led by high performing credit unions, it would seem that the acquired credit unions, at least in terms of pure technical efficiency, are no less efficient than the industry average. The most important determinant of a credit union being acquired in the Australian case is simply that it is smaller (in terms of asset size). In terms of outcomes, credit union M&As appear to have improved the level of efficiency in the merged institutions, even after several other factors often associated with differences in efficiency are included. Most importantly, it would seem that the merger process in Australia reflects the reorientation of credit union services towards performance in a conventional banking sense. In this manner, a comparable mechanism to that provided by the market for corporate control in the joint stock sector is working to eliminate smaller and relatively inefficient credit unions and transferring their assets to larger and relatively efficient institutions within the sector.

However, the measures of efficiency calculated should be treated with caution. Put simply, as relative measures they tell much about the efficiency of groups of credit unions, but nothing about the efficiency change of the industry as a whole vis-à-vis other deposit-taking institutions, such as banks and building societies. That is, it is not possible to conclude that the efficiency of the credit union industry as a whole has improved as a result of M&A activity, only that the efficiency of the merged entities has improved relative to non-merged entities in that industry. This limitation highlights a possible area of future research. That is, similar techniques to the present study could be used to analyse the determinants of merger activity and merger-related outcomes in related industry sectors, such as building societies, life insurance companies and commercial banks. Likewise, an attempt could be made encompass the broad range of deposit-taking institutions, including banks, building societies and credit unions, in a single study. This may serve to highlight additional issues of concern to policy-makers and other interested parties.

Acknowledgments

The author would like to thank participants at the 1999 Accounting Association of Australia and New Zealand (AAANZ) Annual Conference and two anonymous referees for helpful comments on an earlier version of this paper. The assistance of the Australian Prudential Regulation Authority (APRA) in providing the requisite data and the financial support of an Australian Research Council (ARC) grant is also gratefully acknowledged.

NOTES

1. This paper uses the term 'merger' to characterise the incorporation of the assets of a credit union into an existing economic entity. Though this term is consistent with the literature, it is qualified in the context of cooperative societies (such as building societies and credit unions), and does not distinguish between the voluntary and involuntary transfer of arrangements (forced merger).
2. Brown *et. al*. (1999) have presented anecdotal evidence indicating that some credit unions may choose to exit (via merger) rather than face an expected increase in regulation-related fixed costs. These fixed costs may include the costs of complying with the extensive prudential regulations introduced by AFIC in 1992 as well as the costs of acquiring and implementing new software and information systems.
3. The data used in the analysis follows Australian accounting convention by being based on the financial year 1 July to 30 June as against the calendar year. As an example, the year denoted 1996 in the study corresponds to the financial year ending 30 June 1996.
4. In the only comparable Australian study, Garden and Ralston (1999) also examine the efficiency effects of credit union mergers. However, in that study only mergers in the 1994 financial year are examined, with no analysis made of the role of efficiency as a determinant of M&A activity, nor any distinction between acquiring and acquired credit unions
5. The final set of independent variables was drawn from eleven key ratios used by the regulatory agency plus another twelve suggested by previous studies.
6. At least four different approaches have been employed in the analysis of financial institution efficiency, all of which differ in the assumptions placed on the probability distributions of the X-efficiency differences and unrelated random errors (Berger *et al*., 1993). These are: the econometric frontier approach; the thick frontier approach; the distribution-free approach; and the current data envelopment analysis or DEA approach.

REFERENCES

Aly HY, Grabowski R, Pasurka C and Rangan N. 1990. Technical, scale and allocative efficiencies in U.S. banking: An empirical investigation. *The Review of Economics and Statistics*: 211–218.

Australian Financial System Inquiry. 1981. *Australian Financial System: Final Report of the Committee of Inquiry into the Australian Financial System*, Canberra: AGPS.

Banker RD, Charnes A and Cooper WW. 1984. Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science* **30**(9): 1078–1092.

Berg AA, Førsund FR, Hjalmarsson L and Suominen M. 1993. Banking efficiency in the Nordic countries. *Journal of Banking and Finance* **17**(2-3): 371–388.

Berger AN and Humphrey DB. 1997. Efficiency of financial institutions: International survey and directions for future research. *European Journal of Operational Research* **98**(2): 175–212.

Berger AN, Demsetz RS and Strahan PE. 1999. The consolidation of the financial services industry: causes, consequences and implications for the future. *Journal of Banking and Finance* **23**(2-4) 135–194.

Berger AN, Hunter WC and Timme SG. 1993. The efficiency of financial institutions: A review and preview of research past, present, and future. *Journal of Banking and Finance* **17**(2-3): 221–249.

Brown R, Brown R and O'Connor I. 1999. Efficiency, bond of association and exit patterns in credit unions: Australian evidence. *Annals of Public and Cooperative Economics* **70**(1): 5–23.

Charnes A, Cooper WW and Rhodes E. 1978. Measuring the efficiency of decision making units. *European Journal of Operational Research* **2**(6): 429–444.

Coelli T, Rao DSP and Battese GE. 1997. *An Introduction to Efficiency and Productivity Analysis*, Boston: Kluwer.

Cooper WW, Seiford LM and Tone K. 2000. *Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References and DEA-Solver Software*, Boston: Kluwer.

Davis K. 1994. Prudential regulation and cooperative financial institutions. *Australian Journal of Management* **8**(1): 31–46.

Drake L and Weyman-Jones TG. 1996. Productive and allocative inefficiencies in U.K. building societies: A comparison of non-parametric and stochastic frontier techniques. *The Manchester School* **64**(1): 22–37.

Elyasiani E, Mehdian S and Rezvanian R. 1994. An empirical test of association between production and financial performance: The case of the commercial banking industry. *Applied Financial Economics* **4**(1): 55–59.

Favero CA and Papi L. 1995. Technical efficiency and scale efficiency in the Italian banking sector: A non-parametric approach. *Applied Economics* **27**(4): 385–395.

Ferrier GD and Lovell CAK. 1990. Measuring cost efficiency in banking: Econometric and linear programming evidence. *Journal of Econometrics* **46**(1-2): 229–245.

Financial System Inquiry. 1997. *Financial System Inquiry: Final Report*, Canberra: AGPS.

Fried HO, Lovell CAK and Turner JA. 1996. An analysis of the performance of university-affiliated credit unions. *Computers and Operations Research* **23**(4): 375–384.

Fried HO, Lovell CAK and Vanden Eekaut P. 1993. Evaluating the performance of US credit unions. *Journal of Banking and Finance* **17**(2-3): 251–265.

Fried HO, Lovell CAK, Yaisawarng S. 1999. The impact of mergers on credit union service provision. *Journal of Banking and Finance* **23**(2-4) 367–386.

Garden K and Ralston D. 1999. The X-efficiency and allocative efficiency effects of credit unions mergers. *Journal of International Financial Markets, Institutions and Money* **9**(3): 285–301.

Grabowski R, Mathur I and Rangan N. 1995. The role of takeovers in increasing efficiency. *Managerial and Decision Economics* **16**(3): 211-223.

Miller SM and Noulas AG. 1996. The technical efficiency of large bank production. *Journal of Banking and Finance* **20**(1): 495–509.

Piesse J and Townsend R. 1995. The measurement of productive efficiency in UK building societies. *Applied Financial Economics* **5**: 397–407.

Ralston D. 1998. *The Impact of Regulation on the Stability of Financial Institutions: A Risk Measure Approach*. Paper presented to the 11th Annual Australasian Finance and Banking Conference, University of New South Wales.

Rhoades SA. 1993. Efficiency effects of horizontal (in-market) bank mergers. *Journal of Banking and Finance* **17**(2-3): 411–422.

Shaffer S. 1993. Can megamergers improve bank efficiency? *Journal of Banking and Finance* **17**(2-3): 423–436.

Thompson S. 1997. Take-over activity among financial mutuals: An analysis of target characteristics. *Journal of Banking and Finance* **21**(1): 37–53.

Worthington AC. 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): 67–84.

Worthington AC. 1999. Measuring technical efficiency in Australian credit unions. *The Manchester School* **67**(2): 231–248.

Worthington AC. 2000. Cost efficiency in Australian non-bank financial institutions: A non-parametric approach. *Accounting and Finance* **40**(1): 75–97.