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The determinants of non-bank financial institution efficiency: A stochastic cost frontier approach

ANDREW C. WORTHINGTON
School of Economics and Finance
Queensland University of Technology, Brisbane QLD 4000, Australia.

A two-stage estimation procedure is employed to evaluate non-bank financial institution efficiency. In the first stage, maximum-likelihood estimates of an econometric cost function are obtained for a cross-section of one hundred and fifty Australian credit unions. The results indicate that a typical credit union's costs in 1995 were only some seven percent above what could be considered efficient. The second stage uses limited dependent variable regression techniques to relate credit union efficiency scores to structural and institutional considerations. The results indicate that non-core commercial activities are not a significant influence on the level of cost inefficiency, though asset size, capital adequacy regulation, and branch and agency networks are. A primary influence on credit union efficiency would appear to be the industrial or community associational bond under which they were created, and to a lesser extent the state-based regulatory framework.

I. INTRODUCTION

In a recent survey article Berger *et al.* (1993, p. 221) argued that "in a world in which the structures of financial services industries are changing rapidly, it is important to determine the cost and revenue efficiency of the evolving institutions". Not only does efficiency have important ramifications for the institutions themselves - such as profitability, competitiveness and solvency - but also in terms of the demands placed upon regulatory authorities, and ultimately taxpayers, in the provision of low risk, financial intermediation (Berger, *et al.* 1993). However, when examining existing research in the area of financial institution efficiency, a number of salient points emerge. First, while scale and scope efficiencies have been extensively studied, primarily in the context of US financial institutions, "..relatively little attention has been paid to measuring what appears to be a much more important source of efficiency differences - X-inefficiencies, or deviations from the efficient frontier" (Berger, *et al.* 1993, p. 222).[1] Put differently, differences in management's ability to control costs or promote revenues appears to comprise a far more important source of financial institution efficiency than either scale or scope efficiencies (Berger and Humphrey, 1991) [see Allen and Rai (1996) for an international assessment)].[2] Secondly, even when studies have concerned themselves with this area "...nearly all such papers [have] measured X-efficiency for US commercial banks, with less than a handful of papers measuring the efficiency of non-bank financial institutions or banks outside the US" (Berger, *et al.* 1993, p. 222). It is with these considerations in mind that the present study was undertaken.

The selection of Australian credit unions for this purpose is appropriate for a number of reasons. First, in spite of a relative decline in importance within the Australian financial services industry, credit unions still account for some ten percent of total financial institution assets, and some twelve percent of total personal finance lending commitments.[3] Moreover, recent changes to the fee structure of major commercial banks has seen a flight of deposits to credit unions; if not notable in total value, at least so in terms of the number of new deposit accounts.[4]

Second, since the 1980s the fortunes of the Australian thrift industry (largely state-regulated building societies, credit unions, and friendly societies) has directly reflected the changing federal regulatory environment. Whilst the building society sector has been characterised by the procurement of banking licences, the credit union industry is largely distinguished by merger activity. Moreover, credit unions in Australia have also achieved a high degree of interstate and industry-wide cooperation, particularly in relation to automatic teller machines (ATMs) and electronic funds transfer at point of sale (EFTPOS).[5] The extent to which these modifications have affected the institutional and competitive environment of credit unions is as yet unquantified.

Third, an adequate amount of statistical information is an obvious *sine qua non* for estimations of this type. Fortunately, sets of extensive, comparable and consistent data exist for credit unions; a requirement that is somewhat less likely to hold for Australian commercial banks. Fourth, there is some degree of correspondence between the position of Australian credit unions and the decline of the troubled US savings and loans (S&Ls) industry. In the latter's case, "the most cited factors contributing to this downfall have been interest rate risk, deregulation, and the economic decline of specific geographic markets [and] more recently, the possibility of X-inefficiency in the use of inputs and outputs has been offered" (Berger *et al*. 1993, p. 236).[6] Given that X-inefficiency has been empirically linked to the failure of thrift institutions in the US, there is a compelling case for the analysis of these factors in the Australian institutional milieu.[7]

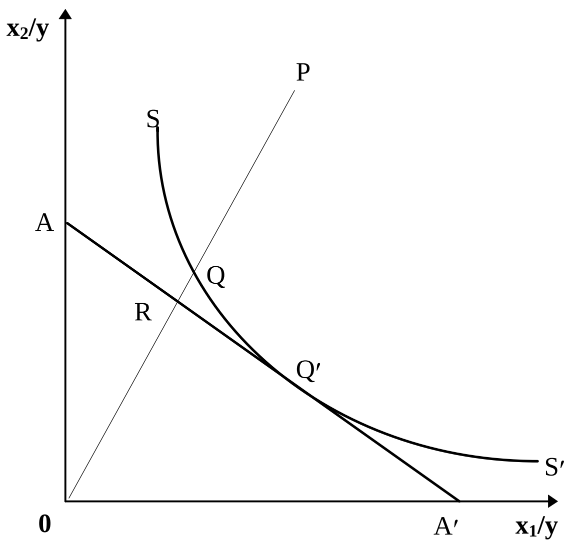
Fifth, whilst some attempt has been made to quantify the economies of scale and scope of Australian thrifts [see, for instance, Esho and Sharpe (1994)], little attention has been directed to the evaluation of cost inefficiencies. Indeed, the need for further research in this area is even more pronounced when one considers the lack of thrift-efficiency studies in general (Fried *et al.* 1993; 1996). Finally, there is at least anecdotal evidence to suggest that the managerial inputs employed in the credit union industry may not be the equal of those found in the commercial banking sector.[8] If this is the case, then the analysis of efficiency may highlight areas of concern to regulators.[9]

The paper itself is divided into four main areas. Section 2 provides a synopsis of the econometric techniques used in the analysis of financial institution efficiency. Section 3 deals with the empirical methodology employed in the paper, and the results are dealt with in Section 4. The paper ends with some brief concluding remarks in Section 5.

II. THE MEASUREMENT OF COST EFFICIENCY

The recent history of efficiency measurement begins with Farrell (1957) who defined a simple measure of firm efficiency which could account for multiple inputs. In his approach, Farrell (1957) proposed that the efficiency of any given firm consisted of two components: technical efficiency, or the ability of a firm to maximise output from a given set of inputs, and allocative efficiency, or the ability of a firm to use these inputs in optimal proportions, given the respective prices. Combining the two measures provides a measure of total or economic efficiency.

Figure 1. *Technical and Allocative Efficiencies*



The essence of Farrell's (1957) argument is contained in Figure 1. Here two inputs, x_1 and x_2, are utilised to produce a single output y, under an assumption of constant returns to scale. The isoquant of the fully efficient firm *SS′* permits the measurement of technical efficiency. For a given firm using quantities of inputs defined by point *P* to produce a unit of output, the level of technical efficiency may be defined as the ratio *OQ/OP*, which is the proportional reduction in all inputs that could be theoretically achieved without any reduction in output. Point *Q*, on the other hand, is technically efficient since it already lies on the efficient isoquant. If the input price ratio *AA′* is known, then allocative efficiency at point *P* is the ratio *OR/OQ*, where the distance *RQ* is the reduction in production costs which would occur if production occurred at *Q'* - the allocatively and technically efficient point, rather than *Q* - the technically efficient, but allocatively inefficient point. Hence, total economic efficiency is the ratio *OR/OP*, with the cost reduction achievable being the distance *RP*.

It is Farrell's (1957) suggestion that efficiency could be measured in reference to an idealised frontier isoquant - or equivalently, disturbances in an econometric model - that forms the basis of subsequent empirical analysis [for surveys, see Førsund, Lovell and Schmidt (1980), Seiford and Thrall (1990), Greene (1993), Lovell (1993), Bauer *et al*. (1993), and Ali and Seiford (1993)]. Within this, 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. These are: (i) the econometric frontier approach; (ii) the thick frontier approach; (iii) the distribution-free approach; and (iv) the data envelopment analysis or DEA approach.

First, the econometric frontier approach generally assumes a two-component error structure such that the inefficiencies follow an asymmetric half-normal distribution and the random errors are normally distributed. Studies by Ferrier and Lovell (1990), Bauer *et al*. (1993), Esho and Sharpe (1996) and Cebenoyan *et al*. (1993) have used this approach. Second, the thick frontier approach posits that deviations from predicted costs within the lowest average-cost quartile of financial institutions are the result of random error, whilst differences between the highest and lowest average-cost quartile reflect inefficiencies plus exogenous differences in output quantities and input prices. Examples of work in this area include Berger and Humphrey (1991) and Bauer *et al*. (1993). Third, supporters of the distribution-free approach argue that efficiency differences are stable over time, whilst random errors average out over time. Bauer *et al*. (1993) and Berger (1993) have undertaken work in this area. Finally, the data envelopment analysis approach assumes that all deviations from the estimated frontier represent inefficiency. This approach has been applied to financial institutions by Elysiani and Mehdian (1990), Miller and Noulas (1996), Drake and Weyman-Jones (1996) and Worthington (1996).

III. MODELS AND HYPOTHESES

3.1 Model selection

In terms of the estimation technique which follows, a stochastic frontier cost function approach is employed. The most notable features of this model are: (i) the estimation of a cost, rather than a production function, and (ii) the use of firm-specific variables to identify the sources of cost inefficiency.

Firstly, an alternative dual form - such as a cost or profit function - of the production technology is to be preferred for at least two reasons. First, more often than not the explicit assumption of the production function approach that input levels are fixed, and that managerial inputs are attempting to maximise output, will not hold. In particular, one would expect that for a financial institution, such as a credit union, the imposition of capital adequacy requirements would tend to restrict the amount of output possible in any one time period. Hence, a suitable behavioural objective for these institutions would be that of cost minimisation, rather than output maximisation. Second, credit unions are multiple output concerns, encompassing both loans (consumer, property, commercial) and investment in financial assets (cash, governmental securities, bank bills and negotiable certificates of deposit). The argument for a cost function is enhanced *a fortiori*, given the necessity of integrating multiple financial outputs (Cebenoyan *et al*. 1993; Mester, 1987, 1993; McKillop and Glass, 1994; Piesse and Townsend, 1995). The following model is specified:

$$TC_i = \beta X_i + \varepsilon_i \qquad i = 1,....,N. \qquad (1)$$

where TC_i is the logarithm of the total cost of production of the *i*-th firm; X_i is a k×1 vector of input prices *P* and output *Q*, β is a vector of unknown parameters to be estimated, and ε_i is a disturbance term where:

$$\varepsilon_i = (V_i + U_i) \qquad i = 1,....,N. \qquad (2)$$

As per the earlier discussion, the disturbance is composed of two influences: V_i are random variables assumed to be $N(0,\sigma_v^2)$ and independent of U_i, which are non-negative random variables assumed to account for the cost of inefficiency in production and are distributed $|N(0, \sigma_U^2)|$.

The error term is decomposed using the conditional distribution approach proposed by Jondrow *et al*. (1982) for a half-normal distribution; providing an unbiased, though inconsistent, estimate of the cost of inefficiency. The measure of cost efficiency relative to the cost frontier is defined as:

$$E[U|\varepsilon] = [\sigma\lambda/(1+\lambda^2)][\phi(\varepsilon\lambda/\sigma) /\{1-\Phi(\varepsilon\lambda/\sigma)\} + \varepsilon\lambda/\sigma] \qquad (3)$$

where $\sigma = (\sigma_V^2 + \sigma_U^2)^{1/2}$ and $\lambda = \sigma_U/\sigma_V$, ϕ is the standard normal density function, and Φ the cumulative normal density function, and all other terms are as previously defined. To obtain estimates of (3), maximum likelihood estimates of the parameters of the stochastic cost frontier (1) are first estimated.

Secondly, not content with merely estimating firm-level efficiencies, many studies have sought to identify the sources of said inefficiencies. This has often involved regressing the predicted inefficiencies on firm-specific variables, such as managerial inputs, agency issues, and financial structure. These usually take the form of either (i) nonparametric, nonstochastic techniques (see, for instance, Drake and Weyman-Jones, 1992; Favero and Papi, 1995) or (ii) parametric, stochastic techniques (such as Cebenoyan *et al*. 1993; Mester, 1993) in estimating cost efficiencies; followed by parametric, stochastic techniques to attribute variation in these efficiencies. Given that the efficiency measure calculated in equation (3) is a limited dependent variable, such that $0 \leq U_i$, a Tobit model takes the generalised form:

$$Y_i = \delta Z_i + u_i \qquad i = 1,....,N. \qquad (4)$$

where Y_i is the cost efficiency of the *i*-th credit union, Z_i is a p×1 vector of variables which may influence the efficiency of a credit union, and δ is a 1×p vector of parameters to be estimated.

Finally, in order to estimate the parameters detailed in equation (1), the efficiency measure in (3), and the parameters detailed in (4) two further *a priori* specifications are required. These are: (i) the section of a suitable cost function, and (ii) the identification of a vector of variables used to explain the differences in predicted efficiencies between firms in an industry. These are detailed in Sections 3.2 and 3.3 respectively.

3.2 Cost function formulation

Estimating equation (1) requires the formulation of a suitable cost function, of which the Cobb-Douglas and translog (transcendental logarithmic) are the most commonly used in stochastic frontier analyses. Following Cebenoyan *et al.* (1993) and Esho and Sharpe (1996) for an X-efficiency analysis, and Mester (1993), McKillop and Glass (1994) and Esho and Sharpe (1994) for scale and scope analyses, a translog cost function is employed. The advantages of this formulation are twofold. First, the translog places no *a priori* restrictions on the elasticity of substitution between inputs, and second, economies of scale are not restricted to take the same value across all firms. However, the translog suffers a number of deficiencies. Esho and Sharpe (1994, p. 261) observe that most of these relate to the estimation of economies of scope and scale. However, problems with the large number of parameters to be estimated also applies to cost efficiency estimates. In part, this issue is resolved by the large number of credit unions operating in Australia, but it also serves to highlight concerns that might appear if the same procedure is employed with, say, Australian commercial banks or building societies. Accordingly, to estimate the cost function in equation (1), the following translog cost formulation is specified:

$$lnTC = \alpha_0 + \Sigma_i lnQ_i + \Sigma_j \beta_j lnP_j + ½\Sigma_i\Sigma_k\delta_{ik}lnQ_i lnQ_k + ½\Sigma_j\Sigma_h\gamma_{jh}lnP_j lnP_h + \Sigma_i\Sigma_j\rho_{ij}lnQ_i lnP_j \quad (5)$$

for $i,k = 1, . . . , a$ and $j, h = 1, . . . , p$ where TC = total operating and interest costs, P_j = unit price of factor input j, and Q_i = quantity of output i.

The variables used to estimate (5) 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). The variables apply to a sample of one hundred and fifty credit unions.

The actual specification of these variables is contingent upon one's *a priori* conceptualisation of financial institution behaviour, for which two primary approaches exist. The first of these, the production approach, conceptualises financial institutions, such as credit unions, as producers of loan and deposit accounts. In this instance, outputs are defined as the number of such accounts, or their associated transactions, whilst capital and labour expenses, and total operating costs, define the firm's inputs and total costs respectively. The second approach to financial institution behaviour is termed the intermediation approach. Here financial institutions are viewed as "...intermediators of financial services rather than producers of loan and deposit account services, and the values of loans and investments are used as output measures; labour and capital are inputs to this process, hence operating costs plus interest costs are the relevant cost measure. Deposits may be either inputs or outputs" (Colwell and Davis, 1992, p. 113). In most instances, the intermediation approach is the preferred conceptualisation (Colwell and Davis, 1992, p. 113).[10] Furthermore, the intermediation approach is consistent with both existing commercial bank studies, and specific thrift analyses such as Fried *et al.* (1993). Brief reviews of these conceptualisations, along with several others, may be found in Colwell and Davis (1992) and Favero and Papi (1995).

The five outputs used in the present study follow the thrift analyses of Hardwick (1990), Cebenoyan *et al.* (1993), Drake and Weyman-Jones (1992; 1996) and Piesse and Townsend (1995). They are: personal loans and consumer credit facilities Q_1; property loans and real estate loans Q_2; commercial loans Q_3; deposits with other thrift institutions and banks Q_4; and finally, other securities Q_5. Total cost TC is measured as total operating plus interest expenses. The three inputs used in the present study are the price of physical capital P_1, the price of deposits P_2 and the price of labour P_3.

TABLE 1. *Cost function and explanatory variables*

Cost function variables			*Explanatory variables*		
TC	Total cost	Operating plus interest expenses of the *i*-th credit union.	Z_1	Assets	Total financial and non-financial assets of the *i*-th credit union.
Q_1	Personal loans	Personal loans and consumer credit facilities of the *i*-th credit union.	Z_2	Capital	Total capital divided by total assets of the *i*-th credit union.
Q_2	Property loans	Property and real estate loans held by the *i*-th credit union.	Z_3	Commercial	Total commercial loans held divided by total assets of the *i*-th credit union.
Q_3	Commercial loans	Commercial loans held by the *i*-th credit union.	Z_4	Fee	Total fee and commission income divided by total income of the *i*-th credit union.
Q_4	Deposit securities	Current and term commercial bank deposits of the *i*-th credit union.	Z_5	Branch	Number of branches operated by the *i*-th credit union.
Q_5	Other securities	All other financial investments, including bank bills, negotiable certificates of deposit, Commonwealth/State/Local and Semi-Government securities, etc. of the *i*-th credit union.	Z_6	Agency	Number of agencies operated by the *i*-th credit union.
P_1	Price of physical capital	Sum of physical capital expenditures (office and equipment expenses, etc.) divided by the book value of net total office premises and equipment (including office buildings and land, leasehold improvements, furniture and fixtures, capitalised leases) of the *i*-th credit union.	Z_7	Industrial	Qualitative variable if the *i*-th credit union established via industrial bond.
P_2	Price of deposits	Total interest expense divided by total deposits and other borrowings of the *i*-th credit union.	Z_8	Community	Qualitative variable if the *i*-th credit union established via community bond.
P_3	Price of labour	Total expenditures on employees divided by the number of full-time equivalent employees of the *i*-th credit union.	Z_9-Z_{15}	NSW, VIC, QLD, SA, WA, TAS, and NT.	Qualitative variable if the *i*-th credit union established in New South Wales, Victoria, Queensland, South Australia, Western Australia, Tasmania, and Northern Territory.

Finally, (5) is reformulated to impose the standard symmetry and linear homogeneity input price restrictions following Cebenoyan *et al.* (1993) and Goldberg and Rai (1996). The reformulated translog cost function is detailed below:

$$lnTC^* = \alpha_0 + \Sigma_i lnQ_i + \Sigma_j \beta_j lnP_j^* + \tfrac{1}{2}\Sigma_i\Sigma_k \delta_{ik} lnQ_i lnQ_k + \tfrac{1}{2}\Sigma_j\Sigma_h \gamma_{jh} lnP_j^* lnP_h^* + \Sigma_i\Sigma_j \rho_{ij} lnQ_i lnP_j^* \qquad (6)$$

where I, $k = 1, \ldots a$ and j, $h = 1, \ldots p - 1$, and $TC^* = TC/P_p$, $P_j^* = P_j/P_p$, and $P_h^* = P_h/P_p$.

3.3 Explanatory variables

The second part of the two-stage estimation procedure involves the specification of a vector of explanatory variables presumed to account for cost inefficiency, as detailed in equation (4). These are intended to evaluate four associated hypotheses on the relationship between financial institution inefficiency and firm-specific variables. The sets of variables selected relate to the firm's (i) operational characteristics, (ii) organisational structure, and (iii) institutional or environmental framework. These variables are detailed in Table 1.

The first group of explanatory variables relate to firm-specific operational characteristics. The first variable, total assets Z_1, is intended to control for the overall size of a credit union (Hardwick, 1990; Drake and Weyman-Jones, 1992; Mester, 1993; Cebenoyan *et al.* 1993). It may be argued that larger credit unions direct more managerial inputs into identifying and resolving inefficiency; *ex ante* one would expect a negative coefficient when cost inefficiency is regressed against total assets. The second explanatory variable included is the firm's capital to asset ratio Z_2. All other things being equal, "moral hazard theory suggests [the capital asset ratio] should be inversely related to inefficiency" (Mester, 1993, p. 282). Third, the extent of non-core lending activity is proxied by the level of commercial loan activity Z_3. The hypothesis here is that exposure to non-core loan activity may serve to "impose market discipline" (Mester, 1993, p. 282) on credit union managers - thus a negative coefficient is hypothesised. Finally, a further aspect of diversified credit union revenue behaviour is proxied by the level of income obtained through fees and commissions Z_4. 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 these revenue sources and firm efficiency. However, all other things being equal, an identical coefficient to commercial loans is hypothesised. At the very least, the results should shed some light on the impact of these 'off-balance sheet' activities on firm efficiency.

The second group of explanatory variables relate to the branching behaviour of credit unions, generating three somewhat conflicting hypotheses (Fried *et al.* 1993). The first is that under the intermediation approach, branches Z_5 and agencies Z_6 are recognised as "...central to the intermediation process for most [non-bank financial institutions], it may also be the case that differences in the intensity of branching may be an important factor" (Drake and Weyman-Jones, 1992, p. 5). Accordingly, the number of branches are closely related to the level of financial intermediation provided - and a negative coefficient is inferred. The second hypothesis is that the number of branches and agencies are a critical, and possibly negative factor, in the ability of head offices to promote cost efficient behaviour. In this case, we would expect a positive coefficient *ceteris paribus*. The third hypothesis is that branch services are an output offered jointly with deposit services; a positive coefficient is thus postulated. Of course, the impact of low cost, low productivity agencies is expected to contrast markedly with that of a full-service branch network.[11]

Finally, a group of explanatory variables are included in order to proxy the disparate institutional environments under which Australian credit unions operate (Fried *et al.* 1993; Cebenoyan *et al.* 1993). The first of these relate to the specific bond-type under which the credit union exists, either industrial Z_7 or community-based Z_8. At first impression, we would expect that *ceteris paribus* industrial-bond credit unions should exhibit cost advantages as a result of sponsor-institutionally donated resources; usually in the form of employee compensation and benefits, office occupancy expenses, and office operations expense (Fried *et al.* 1993, p. 256). However, a number of conflicting issues may also arise. First, over time we would expect that the limited potential membership pool of these industrial credit unions would tend to impact upon the efficient operation of the financial institution itself. And second, as membership grows in the unconstrained community-based organisations we would expect that the social and philosophical basis upon which it may have been founded would give way to a market-orientation (O'Brien 1993). The presumption here is that any cost advantages posed by donated resources would soon be outweighed by the limits placed upon membership. In part, evidence of such a hypothesis may be indicated by the level of merger activity found in industrial-bond credit unions.

The last six explanatory variables Z_9 - Z_{15} relate to the state-based legislation under which credit unions operate (Mester, 1993; Fried *et al.* 1993; Cebenoyan *et al.* 1993; Favero and Papi, 1995). In support of this approach, Saunders (1993, p. 552) argues *inter alia*:

> [I]f we are to believe these studies, cost 'X-inefficiencies' range anywhere between 10% and 30%. Of course one feels uncomfortable with such a large cost inefficiency that is as yet unattributed. However, one suspects that is regulation, and the institutional structure produced by regulation, that may be the culprit.

Whilst moves have been made to formulate a national framework of supervision, one would expect that the vast quantum of inherited state-based regulatory differences would remain. To some extent, the uneven development of thrift institutions and their competitors in Australia, and the demographic profiles of the states themselves, would also have some impact. The coefficient would therefore necessarily depend on the relative impact of regulation, and the impact of institutional and structural considerations, amongst other factors. No *a priori* coefficient is postulated.

IV. RESULTS

The results for the normalised translog cost function detailed in equation (6) are found in Table 2. Also included are the parameters σ^2_U, σ^2_V, and λ associated with the variances of the random variables V_i and U_i. A chi-square statistic using these parameters is used to reject the null hypothesis of the absence of the stochastic effects, and therefore the possibility that a standard regression could have been used to estimate the model. The cost efficiency estimates derived from (3) range from 0.0498 to 0.1211 with a mean efficiency level of 0.07794 and a standard deviation of 0.0145. In economic terms these measures indicate how far above the cost frontier a credit union is operating. The suggestion is that a typical credit union in 1995 produced its products at a cost that was approximately seven percent greater than necessary, with overall cost inefficiencies ranging from five percent to over twelve percent. A narrow band of operational characteristics was encountered, suggesting that the move to a federally-supervised regulatory regime, and the high level of merger activity, has created a remarkably homogeneous industrial sector. Whilst these results are consistent with those of Cebenoyan *et al*. (1993), Mester (1993), and others, in the analysis of non-bank financial institution efficiency, variance in samples and estimation techniques precludes valid comparison.

The estimates detailed in Table 2 also appear reasonable in terms of statistical significance, and in satisfying the properties of parameters under neo-classical production theory. Care should be taken in the interpretation of an individual coefficient's significance in that the inclusion of squared and interaction terms is likely to result in multicollinearity, thereby contributing to high standard errors. A more appropriate testing procedure is to simultaneously test the significance of groups of coefficients. Using the likelihood ratio testing procedure with an asymptomatic chi-square distribution a structural test of the restriction that all coefficients are zero is rejected, as is a similar null hypothesis that the nested Cobb-Douglas function is preferred to the translog. Finally, the own-price elasticities for capital (-0.3167) and deposits (-0.0218) are found to be negative, with the cross-price elasticity (0.2347) indicating the substitutability of capital and deposits.

TABLE 2. *Translog cost function final maximum-likelihood estimates*

Variable	Coefficient	Standard Error	Variable	Coefficient	Standard Error	Variable	Coefficient	Standard Error
CONST	-5.7781**	2.3574	lnQ_1Q_2	0.0081*	0.0045	lnQ_1P_1	-0.0045	0.0050
lnQ_1	1.3105***	0.5058	lnQ_1Q_3	0.0015	0.0021	lnQ_1P_2	0.0015	0.2023
lnQ_2	0.0086	0.3244	lnQ_1Q_4	-0.3808***	0.0086	lnQ_2P_1	-0.0049*	0.0024
lnQ_3	-0.1184	0.1402	lnQ_1Q_5	0.0080	0.0083	lnQ_2P_2	0.0062	0.0051
lnQ_4	0.4125	0.6010	lnQ_2Q_3	0.0021**	0.0010	lnQ_3P_1	0.0021*	0.0010

lnQ_5	-0.6029*	0.3630	lnQ_2Q_4	-0.0041	0.0042	lnQ_3P_2	-0.0042	0.0043
lnP_1	-0.0020	0.0004	lnQ_2Q_5	-0.0029	0.0051	lnQ_4P_1	0.1280**	0.0056
lnP_2	0.0029	0.7974	lnQ_3Q_4	-0.0050*	0.0025	lnQ_4P_2	0.1199	0.1781
lnQ_1Q_1	0.0056	0.0043	lnQ_3Q_5	0.0011	0.0020	lnQ_5P_1	-0.0047	0.0045
lnQ_2Q_2	-0.0004	0.0011	lnQ_4Q_5	0.3237***	0.0077	lnQ_5P_2	-0.0085	0.1719
lnQ_3Q_3	0.0009	0.0004	lnP_1P_1	-1.23E-04	1.96E-04	λ	0.4056	
lnQ_4Q_4	0.0098*	0.0056	lnP_2P_2	0.1451	0.1825	σ^2_U	0.0095	
lnQ_5Q_5	-0.1791***	0.0065	lnP_1P_2	6.47E-04	4.47E-04	σ^2_V	0.0578	

Asterisk(s) denote significance: *, **, *** at the .10, .05 and .01 levels, respectively.

The second stage of the estimation procedure involves regressing the predicted cost inefficiencies on a vector of explanatory variables. The Tobit regression coefficients derived from (4) are provided in Table 3. Whilst interpretation of the Tobit model is complicated by the fact that all computations are based on the normalised vector, hypothesis tests are possible using the transformed regression coefficients and the techniques found in Tobin's original article. Using these techniques, of the variables selected to proxy operational characteristics, the level of assets Z_1 and capital Z_2 are significant and conform to the hypothesised sign. The signs of non-core revenue activities, both commercial loans Z_3 and fee income Z_4, do not support the hypothesised results, though fee income is significant. A Wald Chi-square statistic confirms the joint significance of total assets and capital on credit union cost efficiency at the ten percent level, as does an identical test for the revenue hypotheses. These results contrast with those of Cebenoyan *et al.* (1993, p. 164) who found that "...inefficiency differences across [thrift institutions] do not appear to be related to firm size" and affirm the results of Mester (1993, p. 282) such that "...better capitalised thrifts are more efficient".

In terms of organisational structure, both branches Z_5 and agencies Z_6 positively affect credit union inefficiency. From the results it would appear that both agency and branch networks are a relatively costly form of organisational structure - the presumed benefits of a branch network are outweighed by the inability of central offices to control costs and promote revenues. These results are similar to those found by Fried *et al.* (1993, p. 264) in a study of US credit unions, and Drake and Weyman-Jones (1992) of UK building societies, where excessive branching behaviour implied a lower level of cost efficiency.

TABLE 3. *Tobit regression results*

Variable	Normalised coefficient	Standard error	Regression coefficient
z_1	-0.0.2267-05	0.1205-5	-0.5866-7*
z_2	-1.1939	2.0707	-0.0308*
z_3	0.6498	2.1812	0.0168
z_4	4.4509	2.0769	0.1151**
z_5	0.0183	0.0177	0.0004*
z_6	0.0022	0.0047	0.5745-4*
z_7	2.2485	0.4820	0.0581***
z_8	1.9394	0.4860	0.0502***
z_9	0.7398	0.4631	0.0191*
z_{10}	0.6231	0.5088	0.0161
z_{11}	0.4127	0.4998	0.0106
z_{12}	0.4143	0.5678	0.1072
z_{13}	1.1147	0.6500	0.0288*
z_{14}	-0.6866	0.6535	-0.0177
z_{15}	1.2547	1.1233	0.0324
EFF	38.645	2.4099	

Asterisk(s) denote significance: *, **, *** at the .10, .05 and .01 levels, respectively.
Log-likelihood: 287.743

By far the most important determinant of credit union efficiency would appear to be the institutional framework in which they operate. In the first instance, the 'bond' under which a credit union is created has a lasting influence on its operations. As we have seen, industrial-based credit unions appear to suffer cost disadvantages due to limited membership pools and restricted intra-industry diversification. In fact, this would appear to outweigh the negative cost differentials implied by their sponsor's donated resources. Moreover, this would imply that economy-wide structural adjustment has the capacity to influence non-bank financial institution performance and, by implication, solvency. In the second instance, differentials in credit union efficiency still persist from state-based regulation. The Wald Chi-square tests support the joint significance of bond-type and state regulation on credit union cost efficiency at the ninety-nine and ninety-five percent level respectively. The significance of institutional and regulatory frameworks in determining thrift efficiency has been likewise observed by Cebenoyan *et al.* (1993) and Mester (1993) for US S&Ls, and Fried *et al.* (1993) for US credit unions.

V. CONCLUDING REMARKS

A number of points emerge from the present study. Firstly, the stochastic cost frontier estimates indicate that Australian credit unions operated at a high level of cost efficiency in 1995. A typical credit union's costs were only some seven percent above what could be considered necessary. The second part of this paper relates these inefficiency measures to several correlates. All other things being equal, a large, well-capitalised credit union with a small branch network will be more efficient. However, another important contributor to credit union efficiency (or inefficiency) is the state-based regulatory framework within which they operate. Several areas of concern to regulators are highlighted, not least the impact of disparate state regulation, and the implicit constraints placed on industrial-type credit unions. The relatively recent move to a federally-supervised, state-regulated regime may help to mitigate some of these factors..

There are at least three ways in which this research may be extended. First, it may be useful to obtain estimators of thrift (building society or credit union) efficiency using pooled time-series, cross-sectional data. This would not only provide consistent estimators of efficiency over time, but would also indicate improvements in efficiency due to deregulation and so on. A second extension would be to use nonparametric, nonstochastic techniques, such as data envelopment analysis, to evaluate thrift efficiency. It may well be that the imposition of a specific structural form, like that employed in the present context, is not appropriate in assessing the provision of financial services. Finally, similar techniques to the present study could be extended to alternative conceptualisations of financial institution behaviour. More particularly, where accurate data on account transactions and individual deposit characteristics could be obtained, a production approach may provide alternative criteria for assessing cost efficiency. The latter point highlights the necessity for accurate and consistent data being made available for research into non-bank financial institution efficiency.

NOTES

1. The existing literature uses the term X-(in)efficiency to describe all allocative and technical (in)efficiencies, as distinguished from scale and scope (in)efficiencies. The present paper adopts this approach.

2. "Research to date suggests that X-inefficiencies account for on the order of 20% or more of costs in banking, while scale and product mix inefficiencies, when they can be accurately estimated, are usually found to account for less than 5% of costs (Berger, *et al.* 1993, p. 222).

3. The credit union industry in Australia is unevenly distributed across the states and territories, with most credit unions (70% by number) concentrated in the most populous states of NSW and Victoria. A number of factors account for the late and uneven development of credit unions in Australia; the most notable being the post-war relaxation on the creation of credit unions by geographic bond only, and manifold state-based regulation.

4. Prior to deregulation in the 1980s, the state-regulated credit unions primary advantage over the federally-regulated commercial banks was the latters limited access to the consumer credit market. Since then, and given recommendations that credit unions should be treated in the same manner as other financial intermediaries "on competitive neutrality and efficiency grounds", their other primary advantage of concessional taxation has been eliminated.

5 Over 90 percent of Australian credit unions belong to the Credit Union Services Corporation (Australia) Limited (CUSCAL). This entity provides a diverse range of centralised services to its members, including liquidity management, central banking, ATM network access, computer services, and marketing.

6 Australian credit unions may be created on the basis of a geographic (community or parish) or industrial (occupational) bond. Therefore, the decline of specific industrial sectors also poses challenges for the credit union industry.

7 A recent survey identifies the biggest challenges facing Australian credit unions as: (i) the erosion of interest margins, (ii) cross-subsidisation of retail transactions, and (iii) high cost ratios. Moreover, most of the recent growth in new accounts (+ 3.3% for the 12-months to March 1996) has been in the 'high transaction/low balance' category (approximately 20% of all accounts).

8 In a recent paper Fried et al. (1996) have analysed the 'quality' of management in a study of university-affiliated credit unions.

9 The creation of the Australian Financial Institutions Commission (AFIC) in 1992 was intended to provide a state-based, but nationally consistent regulatory framework for thrift institutions

10 A fundamental limitation of the production approach is the exclusion of interest costs as determinants of financial institution behaviour - especially when such expenses "...typically comprise 70-80% of a financial institution's operating costs (Esho and Sharpe, 1994, p. 260). A somewhat more prosaic limitation is the difficulties encountered in collating accurate production data (Colwell and Davis 1992, p. 112). The main drawbacks of the intermediation approach are the mix of stock (balance sheet) and flow (income statement) concepts, and the exclusion of services not proxied by balance sheet magnitudes.

11 An alternative to incorporating branches in the second-stage regression is to include them as an input in the cost function itself. One issue that arises here is that such a procedure will calculate cost efficiencies at the level of the average office, rather than at the firm level [see, for instance, Berger, Hanweck and Humphrey (1987) and Bauer *et al*. (1993)]. Moreover, the trend towards the centralisation of many branch operations has made the concept of individual branch efficiency somewhat inappropriate.

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