The Efficiency of Credit Unions in Hawaii and Puerto Rico [1]

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1. **Background**

Credit unions are important institutions of financial intermediation in both Hawaii (HI) and Puerto Rico (PR). Most credit unions in HI are federally insured (FICUs). The Puerto Rican government insures most credit unions in PR. This study compares only federally insured credit unions. This limit might introduce a severe sample selectivity bias if the object were to compare credit unions generally. The goal of this paper, however, is to compare the performance of FICUs specifically to study the determinants of efficiency and the effect of the higher level of development of the state vs. the lower level of development of the US territory on performance.

Significant differences exist between FICUs in HI and PR. Credit unions in HI are almost twice as large as credit unions in PR. Those in HI also have on average more experience, a lower delinquency rate and a larger membership base than in PR. Yet, the number of FICUs in PR remained stable throughout the time frame of this study (December 1998-December 2000) while it declined in HI. This fact relates to the topic of this study given the observation by Berger and Humphrey (1997) that lower levels of efficiency in the banking system are associated with bank failure.

2. **Data and variable construction**

Credit unions are modeled following the classic article by Sealy and Lundley (1977) who viewed financial institutions as transforming labor, capital and deposits into loans and security investments. All data for this study comes from the year-end Call Reports for 1998, 1999, and 2000 that FICUs must file with the National Credit Union Administration (NCUA). These reports are available from NCUA's web site under the Freedom of Information Act, NCUA (2000).

This study draws on about 50 percent of the population of FICUs in HI and PR. Many observations were deleted because of missing variables or a suspiciously high ratio of fixed costs to capital. The latter indicates a common problem in FICU reporting when a credit union, which has a common bond such as a company, will not report shared resources. Consultation with NCUA officials in Atlanta and Washington, DC, helped insure that the resulting dataset was of good quality.

Table 1 gives variable definitions for the data used in this study, and Table 2 describes the data. All nominal values were deflated by the consumer price index specific to HI and PR. Other variable construction details are available upon request from the author.

Table 1: Variable Definition		
	NCUA ACCOUNT	**DESCRIPTION**
LABOR (x_1)	**Acct_564A+1/2*Acct_564B**	**Number of Full and Part-Times Credit Union Employees**
LABOR PRICE (w_1)	**Acct_210/LABOR**	**Employee Compensation and Benefits/x_1**
CAPITAL (x_2)	**Acct_007+Acct_008**	**Land and Building, and Other Fixed Assets**
CAPITAL PRICE (w_2)	**(Acct_250+Acct_260)/CAPITAL**	**(Office Occupancy and Operations Expense)/x_2**
DEPOSITS (x_3)	**Acct_018**	**Total Shares and Deposits - Total**
DEPOSIT PRICE (w_3)	**(Acct_380+Acct_381)/DEPOSITS**	**(Dividends on Shares and Interest on Deposits)/x_3**
LOANS (y_1)	**Acct_025B**	**Amount-Total**
SECURITY INVESTMENTS (y_2)	**Acct_799**	**Total Investments**
LOCATION(z_1)	**STATE**	**The credit union's state address.**
EXPERIENCE(z_2)	**2001-YEAR_OPENED**	**2001-the year credit union was organized**
DELINQUENCY RATE (z_3)	**Acct_041B/LOANS**	**(Total Amount of Delinquent Loans)/ y_1**
MEMBERSHIP_SIZE (z_4)	**Acct_083**	**Number of current members**

Table 2: Summary Statistics

(Standard Deviation in Parenthesis)

Variables	HAWAII i=50 t=3	PUERTO RICO i=9 t=3
Loans (y_1)*	33002 (51754)	24878 (22786)
Investment (y_2)*	26471 (37511)	11409 (14503)
Labor price (w_1)*	39 (6)	27 (5)
Labor (x_1)	21 (27)	16 (11)
Capital price (w_2)	1.28 (1.30)	1.44 (1.00)
Capital (x_2)*	1679 (2877)	769 (904)
Deposit price (w_3)	0.036 (0.006)	0.043 (0.007)
Deposit (x_3)*	54635 (80926)	33141 (31498)
Location (z_1)	---	---
Experience (z_2)	53 (12)	43 (8)
Delinquency (z_3)	0.018 (0.018)	0.021 (0.010)
Membership size (z_4)	9257 (11585)	5955 (4316)
Percentage of FICUs Population Used	47%	50%

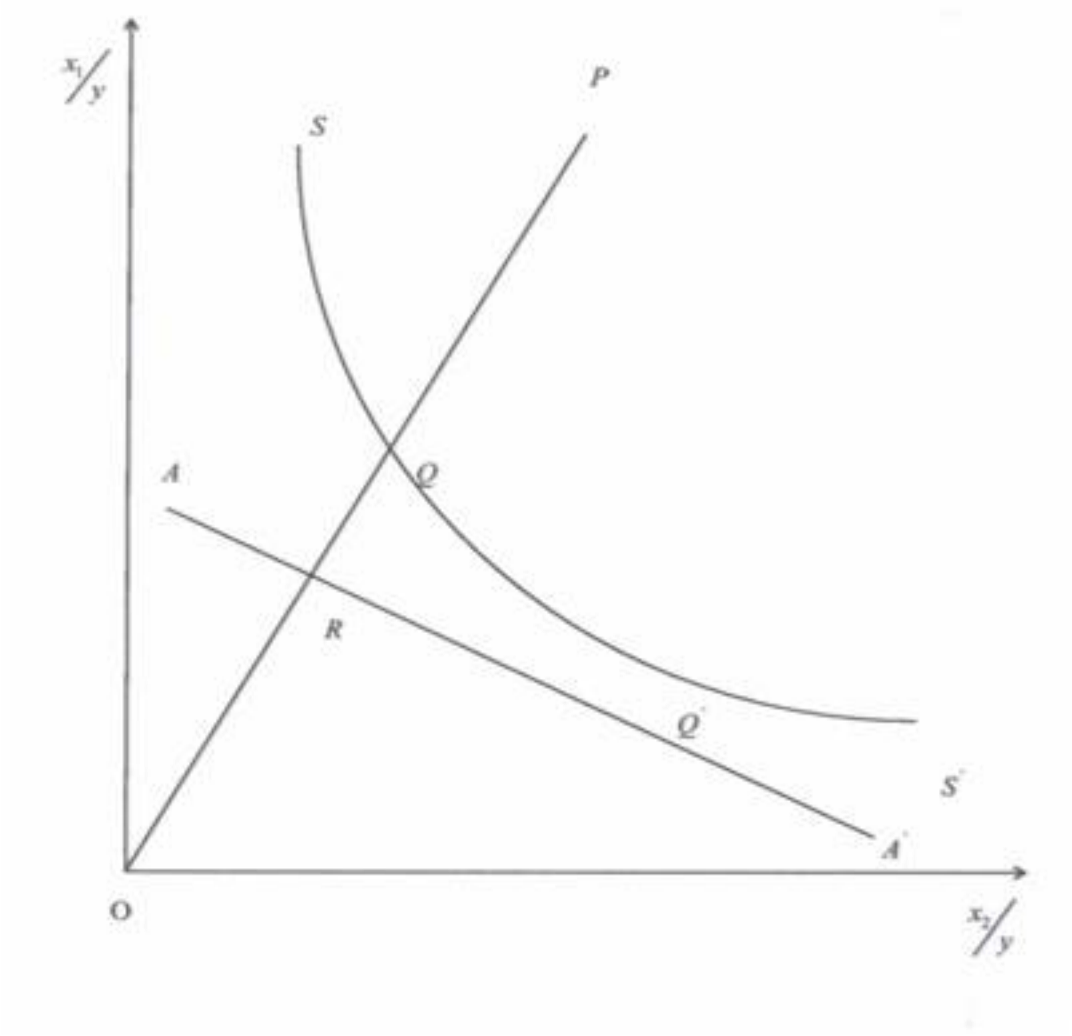
*** in thousands of dollars**

3. **Methodology**

The microeconomic study of productive efficiency started with a paper by Farrell (1957) who observed that firms might operate below the production function because of inefficient behavior. Microeconomics has traditionally concerned itself with studying allocative efficiency rather than technical efficiency.[2] When economists use least squares to estimate production functions generally average rather than best practice technology has been identified.[3] The notion of a production frontier springs from the attempt to construct the best-observed production practice by enveloping firm-level data on inputs and outputs as tightly as possible. Frontier analysis can be used to benchmark credit unions and to explain the variation in performance in terms of a set of variables that are internal and external to the firm.

The various efficiency measures will be discussed to the extent that they are relevant to the application presented here. Figure 1 shows the two inputs per unit of output that the firm operating at point P is observed to use. The isoquant $SS^{'}$ shows the various combinations of inputs that an efficient firm would use to produce a unit of output. Point Q shows an efficient firm using the two inputs in the same proportions as P. The *technical efficiency* of P is the ratio of the distances OQ/OP since firm Q produces the same output using a fraction OQ/OP of the each factor as P. This measure takes a value of 1 for a perfectly efficient firm, and it approaches zero as the firm becomes more inefficient. Allocative or price efficiency is the ratio OR/OQ which is the extent to which a firm uses the inputs in optimal proportions given their prices. Cost efficiency is defined as OR/OP, which represents the fraction of actual costs and is the product of the technical and the allocative efficiency measures. This represents an input-oriented measure which can be generalized to allow non-constant or variable returns to scale by changing the axis labels of figure 1 to x_1 and x_2 and by assuming that the isoquant represents the lower bound of the input requirement set associated with the production of a given set of output.

Figure 1: Various Efficiency Measures



If one assumes that the technology exhibits variable returns to scale, one can calculate scale efficiency by using the so-called BCC model, proposed by Banker, Charnes and Cooper (1984), which is a modification of the constant returns to scale problem, the CCR model proposed originally by Charnes, Cooper and Rhodes (1978). Scale efficiency is defined as the ratio of efficiency measured using the CCR model to that using the BCC model, $SE(y_i, x_i) = \frac{\theta_{CCR}}{\theta_{BCC}}$. Thus technical efficiency is the product of technical efficiency devoid of scale effects (pure technical efficiency) and scale efficiency, $TE = PTE \times SE$. Cost efficiency is defined as the product of an input price vector times optimal input quantities divided by the product of input prices times actual vector quantities, $CE = \frac{w_i' x_i^*}{w_i' x_i}$. Cost efficiency is then the product of pure technical efficiency times allocative efficiency, $CE = PTE \times AE$.

The mathematical formulation of the BCC model which needs to be solved for each observation is:

$$
\begin{aligned}
&\min_{\theta,\lambda} \theta \\
&s.t. \\
&-y_i + Y\lambda \geq 0 \\
&\theta x_i - X\lambda \geq 0 \\
&\lambda \geq 0 \\
&e'\lambda = 1
\end{aligned}
\qquad (1)
$$

Each of the I firms uses inputs $x_i = (x_1, \ldots, x_n)'$ to produce outputs $y_i = (y_1, \ldots, y_m)'$. The input matrix X has dimension n by I; the output matrix Y, has dimension m by I; l is an I by 1 vector of constants; θ is a scalar, and e is a vector of ones. Solving program for each producer generates I optimal values (θ^*, λ^*). The calculated value of θ is the efficiency score for the *ith* firm. It determines the potential ability of this producer to decrease all inputs while producing the same output and still remain within the bounds of the best-practice frontier of the sample. Program (1) has an input orientation since it can be assumed FICUs try to minimize costs. If the firm is not a best practice firm, its efficiency score is less than 1. Fully efficient firms receive an efficiency score of 1.

The availability of information of input prices in the data downloaded from NCUA makes possible to measure and decompose cost efficiency into its pure technical and allocative components. Two linear programs need to be solved for each FICU in the sample; the first corresponds to program (1) and the other to the variable-returns-to scale cost minimization DEA program:[4]

$$
\begin{aligned}
&\min_{\lambda, x_i^*} w_i' x_i^* \\
&s.t. \\
&-y_i + Y\lambda \geq 0 \\
&x_i^* - X\lambda \geq 0 \\
&\lambda \geq 0 \\
&e'\lambda = 1
\end{aligned}
\qquad (2)
$$

where x_i^* is the cost minimizing vector of input quantities given the vector of input prices and the output levels y_i.

A non-parametric test is employed to determine whether or not the assumption of a common technology is appropriate when measuring efficiency for both HI and PR. A test for differences in mean efficiency was employed as well [Cooper, Seiford and Tone (2000)]. A tobit random effects model is used to explain variation in measured efficiency in terms of four variables external or internal to the firm hypothesized to influence FICU efficiency. Efficiency estimates were obtained using Coelli (1996).

4. **Results and Discussion**

Table 3 presents a test of the difference in technology in which rankings are derived by first assuming separate frontiers and then by assuming a pooled frontier. Only the 1998 PTE the null hypothesis is rejected at less than 10%. Table 4 presents the mean efficiency results for FICUs in HI and PR for 1998, 1999 and 2000. Table 5 indicates that the following differences are significant at less than 10 %: in 1998 PR had a higher SE; in 1999 HI had a higher CE, PTE and SE; and in 2000 PR had a higher CE, PTE, AE and SE.

Table 3: Test for Difference Between Pooled and Separate Frontier Distributions

Two-sample Wilcoxon rank-sum (Mann-Whitney) test*
(significance level in parentheses)

Variables	1998	1999	2000
CE	0.88 (0.38)	0.94 (0.35)	0.84 (0.40)
PTE	1.72 (0.09)	1.14 (0.25)	1.17 (0.24)
AE	0.40 (0.69)	0.68 (0.49)	0.67 (0.50)
SE	-0.97 (0.33)	0.16 (0.88)	0.51 (0.61)

- **Ho: Distribution of efficiency scores (frontier==pooled) = (frontier==separate samples)**

Table 4: Efficiency Scores Means for pooled Tecnology

	Hawaiian FICUs		
Variables	1998 i=50	1999 i=50	2000 i=50
CE	0.745	0.810	0.785
PTE	0.933	0.973	0.944
AE	0.794	0.830	0.828
SE	0.977	0.989	0.979
	Puerto Rican FICUs		
Variables	1998 i=9	1999 i=9	2000 i=9
CE	0.784	0.788	0.817
PTE	0.938	0.939	0.963
AE	0.830	0.835	0.843
SE	0.990	0.982	0.987

Table 5: Test for Difference in Means of Efficiency Scores for Pooled Sample			
Two-sample Wilcoxon rank-sum (Mann-Whitney) test* (significance level in parentheses)			
Variables	1998	1999	2000
CE	0.96 (0.34)	2.08 (0.04)	2.44 (0.01)
PTE	0.66 (0.51)	2.85 (0.004)	2.66 (0.01)
AE	0.89 (0.37)	1.59 (0.11)	2.24 (0.02)
SE	1.73 (0.08)	1.88 (0.06)	1.85 (0.06)

* Ho: Distribution of efficiency scores (z_1==HAWAII) = (z_1==PUERTO RICO)

Table 6 shows location in PR significantly affecting technical and allocative efficiency. Experience significantly affected allocative efficiency and membership level influence all types of efficiency. Of note is that membership size affects scale efficiency negatively by indicating decreasing returns to scale. In conclusion, according to this study there does not seem to be a systematic difference in measured efficiency between FICUs in HI and PR. Thus, apparently development levels and status as a state or a territory does not influence the efficiency of credit unions if they are federally insured. Future research will expand on this study by incorporating credit unions insured by the Puerto Rican government, as well. Individual efficiency scores obtained in this study could serve policy makers to allocate resources to their most effective use supplementing other auditing systems used by government institutions in charge of overseeing the sector.

Table 6: Efficiency Analysis				
Tobit Panel Random-Effects Data Model (Standard Error in Parentheses)				
	Technical	Allocative	Cost	Scale

	Efficiency	Efficiency	Efficiency	Efficiency
Location (z_1)	-0.041** (0.020)	-0.068*** (0.013)	0.003 (0.021)	-0.011 (0.009)
Experience (z_2)	0.0007 (0.0008)	0.002*** (0.0004)	0.001 (0.0007)	0.0002 (0.0003)
Delinquency (z_3)	-0.075 (0.371)	-0.512 (0.358)	-0.547 (0.466)	0.198 (0.172)
Membership Size (z_4)	1.46e-06* (8.51e-07)	3.04e-06*** (4.79e-07)	1.82e-06*** (7.05e-07)	-7.09e-07** (3.01e-07)
Constant	0.954*** (0.038)	0.719*** (0.020)	0.746*** (0.033)	0.986*** (0.015)

*** significant at 10%**
**** significant at 5%**
*****significant at 1%**

Notes

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2 Caves (1992) has suggested that the reason that microeconomics has concerned itself mostly with allocative efficiency instead of technical or productive efficiency is the notion that if “it paid to do something more efficiently, somebody else would have done it.”

3 Economists had traditionally estimated an average frontier rather than a best practice technology. For a discussion of this point see, for example, Greene (1993).

4 Except for slightly different notation, the presentation is identical to Coelli, Rao and Battese (1998, p. 162).

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