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ASSESSING THE RELATIVE EFFICIENCY OF CREDIT UNIONBRANCHES USING DATA ENVELOPMENT ANALYSIS

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ABSTRACT

Data envelopment analysis (DEA) is a linear programming-based technique developed to evaluate the relative efficiency of non-profit and public sector decision-making units that use multiple inputs to produce multiple outputs. Technically, as pointed out by Joro, Korhonen and Wallenius (1998), DEA and Multiple Objective Linear Programming (MOLP) aim at suggesting improvements for inefficient units based on the identification of efficient units in a certain space. In this study, DEA is used as a managerial audit tool to identify and measure inefficiencies among a set of 73 independent decision-making units within one federation of the "Caisses Populaires Desjardins" in Québec. The DEA results were compared with the federation's traditional accounting ratio measures. Management found that the DEA results confirmed most of their intuition on which units were unprofitable, and also pinpointed units that made a profit but were operationally inefficient. Overall, they agree with our results and on the benefits of using DEA to complement their accounting ratio analysis for improving the efficiency of some of their "caisses".

Keywords: Data envelopment analysis, performance evaluation, efficiency.

1. INTRODUCTION

In this study the DEA method is used to analyze the relative efficiency of 73 independent credit unions within one federation of the "Caisses Populaires Desjardins" in Québec. The objective is to determine whether this method provides additional information, compared to the ratio analysis often used by this type of institution.

The operational performance of these credit unions (caisses thereafter), using financial ratios, is often defined as the total profit or the operational profit per dollar of assets. When compared with past periods or with other institutions, these ratios give some information about the financial performance of financial institutions. However, their use has many weaknesses. One is that

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the financial ratios cannot consider the value of management's decisions or actions that will affect future performance versus current performance. For example, based on these ratios, an institution that defers the development cost of new products may seem to be performing well, even if its actions weaken future performance. Another weakness is that these ratios only give an aggregate view of the different aspects of past and current performance (funding, marketing and operations) as have been pointed out by Bowlin, Charnes, Cooper and Sherman (1985). An institution can therefore seem like a good performer even though it is weak in certain areas, because its weaknesses are compensated by its strengths in other areas.

The DEA method avoids certain weaknesses of ratio analysis. As our results suggest, it points out less efficient institutions and areas where efficiency could be improved. The method, applied to three different sets of institutions, was useful for all three and showed consistent results. This method is becoming increasingly popular, both in terms of articles published and of its application to practical problems in sectors as varied as the hospital sector (e.g. Banker, Conrad and Strauss, 1986), education (e.g. Bessent and Bessent, 1980, Tomkins and Green, 1988), etc. It was used for the first time in the financial sector by Sherman and Gold (1985) to analyze the performance of 14 branches of an American bank. Since then it was also used on financial sector data by several other authors, namely: Seiford and Zhu (1999), Athanassopoulos (1998), Ladino (1995), Vassiloglou and Giokas (1990). However, as far as we know, this study is one of the first applications of the method to a financial cooperative such as the Caisses Populaires Desjardins. Other studies such as Fried, Lovell and vanden Eechaut (1993) Fried and Lovell (1994), Fried, Lovell and Suthathip (1999) examine US credit unions and Fukuyama, Guerra and Weber (1999) investigate Japanese credit cooperatives. In economics and finance literature particularly, there are numerous papers examining the efficiency and productivity of financial institutions and the reader is directed to Berger and Humphrey (1997) for a survey. Our study is also important because of the size of the overall sample: it covers most of the transactions types (417 transaction types) of the 73 caisses analysed. DEA hypotheses, developed mainly to evaluate the relative efficiency of non-profit decision-making units (DMUs), are better reflected by these institutions. Their mission, as independently managed cooperatives, at least in theory, is not to maximize profit but to provide services for members. Moreover, we also compare DEA efficiency scores and the caisse profitability measures using multinomial logistic regression. Overall, our results show that accounting profits could be an incomplete, or worse, a misleading or short-sighted measure of the caisses' operational efficiency.

The remainder of the paper is organized as follows: Section 2 deals with the specification of variables and describes the DEA method. In section 3 the results are presented and discussed followed by our conclusion in section 4.

2. METHODOLOGY

2.1 Defining the inputs and outputs variables

All the data come from the "confederation des caisses populaires Desjardins" main data file and from the caisses financial statements of 1994. Because of their widely varying operating environments in terms of population served, competition and accessibility, the "caisses" were grouped into three sets. Each set is as homogeneous as possible with respect to market structure and level of accessibility offered through automated tellers or number of locations. They are grouped according to the following parameters: population served, number of locations per credit union, presence of automated tellers and immediate competition. This yields the following sets:

Set 1 15 caisses Small population served, one location only, no automated teller, and no immediate competition.

Set 2 29 caisses Small or medium population served, one location only, one automated teller at the credit union, weak immediate competition.

Table 1: Descriptive Statistics – Credit Unions (caisses) Size

	Set 1 (15 caisses)			Set 2 (29 caisses)			Set 3 (29 caisses)		
	Mem.	Assets ($ m)	Trans. (000)	Mem.	Assets ($ m)	Trans. (000)	Mem.	Assets ($ m)	Trans. (000)
Min.	546	6	70	883	11	167	3,260	31	517
Max.	2,114	32	327	7,369	76	1,277	23,868	277	3,953
Median	1,269	14	166	2,385	27	377	7,332	77	1,107
Total	20,470	244	2,860	74,033	862	11,576	237,170	2,618	38,474
Mean	1,365	16	191	2,553	30	399	8,178	90	1,327
Std. Dev.	507	8.9	78	1,247	15.3	215	4,107	52.4	687

Set 3 29 caisses – Medium or high population served, two or more locations by population area, two automated tellers or more per area, competition ranging from 2 to 14 branches.

The parameters used for the grouping are not based on the size of the caisses, as measured by the number of members, assets, or total number of transactions, even though the size of a credit union often depends on these parameters. For example, set 3 includes most of the largest caisses but also some that are smaller than certain caisses in set 2; the same is true of set 2 in relation to set 1. Table 1 presents the descriptive statistics about the size of the caisses in 1994. For each set, there is a very strong correlation between these three measures of the size of a caisse.

2.1.1 Inputs

Only those inputs that are under management's control are considered. In the literature, some authors try to include the impact of factors over which management has no direct control, such as location of the decision-making units being evaluated (i.e. residential vs industrial, rural vs urban, etc.). We have not done so because the separation into three sets already considers such factors.

1) **FTEE:** the number of full-time employee equivalents. The work time contribution of employees is obviously one of the most significant inputs and is identified as such in the parametric production functions (Cobbs-Douglas, Translog, etc.).
2) **Sq. ft.:** square footage. It is the used caisse space. Production also depends on available space (the capital measure also identified in the parametric production functions). Measuring this variable avoids using the rental cost of space, which would be affected by the location of the credit union, among other things. Using square footage is not perfect since it does not reflect the floor plan, the quality of the environment, etc., but, given the existing literature and the available data, it is considered the most appropriate.
3) **$misc.:** miscellaneous expenditures in dollars drawn from the caisses financial statements. Expenditures are considered only if they are: (a) unrelated to the space; (b) unrelated to salaries; (c) non-statutory or non-regulatory; (d) under management control. They are expenditures necessary for production (miscellaneous supplies, maintenance, guard, security system, etc.) and under management control; they exclude those automatically assigned to the production of outputs.

Table 2 (Panel A) presents descriptive statistics about inputs. This information reflects, among other things, the fact that the size of the caisses was not directly considered in defining the sets.

2.1.2 Outputs

The outputs are measured by the number of transactions completed by each credit union during the year. However, unlike Sherman and Gold (1985), who analyze only 17 types of the most common bank operations, all directly client-related transactions offered by the caisses are included. According to the caisses own classification, there are 690 types of operations, of which 417 transaction types are directly client-related.

The outputs were grouped in terms of transaction complexity (from least to most complex), following Sherman and Gold's classification (1984). However, unlike Sherman and Gold, who determined complexity subjectively, we used the normal completion time for each type of operation, as previously measured by the caisses to allow a more objective definition of four types of output. The complexity outputs can be defined as those taking: 1) less than one minute; 2) between one and five minutes; 3) between 5 and 30 minutes; and 4) usually more than 30 minutes. Of the more than 100 million transactions in the 73 caisses, only those meeting the classification criteria were kept (more than 50 million). As shown in Table 2 (panel B), we have also defined the outputs in relation with the clientele served: Commercial, Credit to individual, Individual savings and others. The results are very similar under both types of output classification: clientele and transaction complexity. We choose to report in the paper only the results obtained from the output grouping using the transaction complexity.

2.2 The DEA Method

The DEA method is a non-parametric methodology initially developed by Charnes and Cooper (1978) to evaluate the relative efficiency of non-profit or public sector decision-making units (DMUs) that use similar inputs to produce a set of outputs. Recent research (eg. Joro, Korhonen and Wallemius, 1998) has shown that the DEA model is structurally identical to the Multiple Objective Linear Programming (MOLP) model.

The DEA method measures the efficiency of a DMU "o" in comparison to a set of "n" DMUs in a given sample. The objective is to establish a level of relative efficiency ($0 \leq \theta \leq 1$) for each DMU by comparing its quantities of inputs and outputs with those of other DMUs of the same set. Identifying one DMU as relatively efficient ($\theta = 1$) implies that no other DMU (or combination of DMUs) in the sample is more efficient. In other words, a DMU will only be efficient in relation to the sample of DMUs analyzed, which does not preclude the existence of a more efficient DMU outside the sample. On the other hand, identifying a DMU as relatively inefficient (q < 1) implies that the sample contains at least one DMU that is more efficient. For each of the inefficient DMUs, the DEA identifies a reference set of DMUs that have efficiency equal to one and that are the closest match in terms of outputs produced. It also supplies, for each of the DMUs, the percentage of inputs that could be eliminated without reducing the level of outputs. Thus, the DEA method provides an empirical evaluation of a DMU's ability to convert its current inputs (x_{ij}) into outputs (y_{rj}) without explicitly specifying the input-output relationship. Two alternative approaches (input- and output-oriented, are available to characterize efficiency in DEA. In this paper we choose to use the input- oriented model in accord with the claim by managers that they are more effective in controlling inputs (number of employees, space used and miscellaneous expenditures) compared to outputs (number of transactions), which require additional marketing efforts. Formally, the model use can be stated as follows:

$$\min \theta \quad \text{subject to} \quad \sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta x_{i0} \qquad i = 1, 2, \ldots, m; \tag{1}$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{r0} \qquad r = 1, 2, \ldots, s; \tag{2}$$

$$\sum_{j=1}^{n} \lambda_j \geq 0 \qquad j = 1, 2, \ldots, n; \tag{3}$$

Table 2: Descriptive Statistics

Panel A: Set Inputs

	Set 1 (15 caisses)			Set 2 (29 caisses)			Set 3 (29 caisses)		
	FTEE	Sq. ft.	$misc. (000)	FTEE	Sq. ft.	$misc. (000)	FTEE	Sq. ft.	$misc. (000)
Min.	2.7	622	41	4.3	2,605	110	12	3,300	239
Max.	12.11	6,008	239	30	9,951	567	109	37,313	1,786
Median	5.7	2,814	130	9.5	5,015	213	30	12,377	576
Total	89	46,886	1,858	328	155,019	6,778	1,001	384,135	19,579
Mean	5.9	3,126	124	11.3	5,345	234	34.5	13,246	675
Std. dev.	2.7	343	14	5.5	2,009	109	19	6,653	331

Panel B: Set Outputs

	Set 1 (15 caisses)					Set 2 (29 caisses)					Set 3 (29 caisses)				
Client\complexity	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total
Commercial	42	116	1	7	165	143	378	4	20	544	247	898	11	31	1 187
Credit to individual	7	46	11	5	69	31	192	45	23	291	107	548	148	72	876
Individual saving	30	1 191	26	281	1 529	82	5 280	100	1 310	6 771	231	18 454	310	4 892	23 888
Individual non classified	178	221	3	0.4	402	902	729	14	2	1 647	2 917	2 504	44	5	5 471
Non classified	74	605	2	14	695	257	1 999	6	61	2 323	950	5 860	20	221	7 051
Total	331	2 179	42	307	2 860	1 415	8 578	169	1 416	11 576	4 453	28 264	534	5 222	38 474

Where DMU_0 represents one of the n DMUs under evaluation. x_{i0} and y_{r0} are respectively the ith input and rth output for DMU_0. s = number of outputs produced by the DMU; m = number of inputs used by the DMU;

The DEA formulation above is the well-known constant returns to scale (CRS) model. The variable returns to scale (VRS) model is obtained by adding $\sum_{j=1}^{n} \lambda_j = 1$ as a constraint. To determine whether our samples are primarily characterized by constant or variable returns to scale, we perform two semi-parametric statistical tests suggested by Banker and Chang (1995). That is, under the null hypothesis of CRS and assuming that $\theta - 1$ follows an exponential distribution, then the ratio $\sum_{j=1}^{n}(\theta_j^{CRS} - 1)/\sum_{j=1}^{n}(\theta_j^{VRS} - 1)$ follows an F-distribution with $(2n, 2n)$ degrees of freedom. In contrast, if we assume that $\theta - 1$ is distributed half-normally, then $\sum_{j=1}^{n}(\theta_j^{CRS} - 1)^2/\sum_{j=1}^{n}(\theta_j^{VRS} - 1)^2$ must be evaluated against the F-distribution with (n, n) degrees of freedom. As shown in Table 3, under all tests and in all our samples, the null hypothesis of CRS cannot be rejected at the conventional 5% level of significance. These results justify our use of the CRS DEA model.

3. RESULTS

In this section we first analyse DEA results. After, we compare these results with the usual "Caisse" accounting performance measures.

3.1 DEA results

The efficiency results of the DEA analyses for the three sets are shown in Table 3. For each of the inefficient caisses, calculating the composite for the reference caisses also allowed input savings as well as possible additional outputs.

To explain the DEA functioning, Tables 4 and 5 show the detailed results of the calculation of these input savings and additional outputs for set 3. From column 2 (Table 4), it can be seen that 11 caisses of the 29 sampled are efficient ($\theta = 1$) and that 18 are inefficient ($\theta < 1$). Column 3 shows the overall reference set and its corresponding coefficients; the reference set represents the relatively efficient caisses to which inefficient caisses are compared when estimating their level of efficiency. The coefficients represent the dual price obtained from the DEA linear programming function. Caisses with a dual price not equal to zero represent the overall reference set of the caisse being evaluated. The production composite required to make a particular caisse efficient is calculated using the linear combination of inputs and outputs of the caisses in its overall reference set, in proportion to their dual price.

Note that the efficiency levels are not a strict ranking of caisses in the usual sense, in that they are evaluated using different overall reference sets. They simply show an inefficient caisse's degree of inefficiency compared to caisses in its reference set. For example, caisse 20 is 89% as efficient as its reference set (C6, C7, C13, C17, and C21), while caisse 27 is 89% as efficient as the caisses in its own reference set (C6, C7, C17, C18, and C23). Overall, this implies that caisses 20 and 27 can reduce their inputs by approximately 11% and continue to produce, at a minimum, the same level of outputs. This is to say that DEA will identify a caisse as inefficient if it actually produces, at a maximum, the same outputs but uses more inputs than the composite, for a given proportion, in its overall reference set. Adopting the production composite of their reference set would allow inefficient caisses to become as efficient as the caisses that already are. For example, as shown in Table 4, caisse 20 would be able to produce at least as many outputs with fewer inputs if it adopted a production composite corresponding to 24% of the inputs and outputs of C6, and 26%, 2%, 28%, and 5% respectively for caisses C7, C13, C17, and C21. Moreover, if it adopted this production composite, it would be able to reduce each of its inputs by 11% and still increase its outputs of level 1 complexity by 7% (see Table 5).

Another example is that if caisse C8 adopted the appropriate composite production (Table 5), it would be able to reduce its staff and miscellaneous expenses by 23%, its space by 30%, and would increase its least complex transactions by 68%.

Table 3: Credit Unions ("Caisses") Efficiency for All Sets

Caisse	θ^{CRS}	Rank	θ^{VRS}	θ^{S}	θ^{CRS}	Rank	θ^{VRS}	θ^{S}	θ^{CRS}	Rank	θ^{VRS}	θ^{S}
C1	0.79	W	0.79	0.79	0.89	O	0.92	0.89	0.83	W	0.83	0.83
C2	1	M	1	1.07	0.75	W	0.76	0.75	0.98	O	1	0.98
C3	1	O	1	1.00	0.71	W	0.74	0.71	0.72	W	0.72	0.72
C4	0.77	W	1	0.77	0.91	O	1	0.91	0.99	O	1	0.99
C5	1	O	1	1.06	1	M	1	1.24	0.95	W	0.96	0.95
C6	0.82	W	0.82	0.82	0.87	W	0.95	0.87	1	M	1	1.12
C7	0.88	W	0.90	0.88	0.81	W	0.84	0.81	1	M	1	1.37
C8	0.99	O	1	0.98	0.81	W	0.87	0.81	0.77	W	0.77	0.77
C9	1	O	1	1.02	1	O	1	1.09	0.96	W	0.96	0.96
C10	1	M	1	2.30	0.82	W	0.94	0.82	0.98	O	0.99	0.98
C11	1	M	1	1.27	0.99	O	1	0.99	0.97	O	0.98	0.97
C12	1	O	1	1.14	0.96	O	1	0.97	0.96	W	1	0.96
C13	0.91	O	1	0.91	0.75	W	0.88	0.75	1	O	1	1.12
C14	1	M	1	1.26	0.90	O	0.96	0.90	0.92	W	0.92	0.92
C15	0.86	W	0.94	0.86	1	M	1	1.18	0.75	W	0.76	0.75
C16					0.83	W	0.92	0.83	0.96	W	1	0.96
C17					0.91	O	0.94	0.91	1	M	1	1.15
C18					0.90	O	0.91	0.90	1	O	1	1.15
C19					0.84	W	1	0.84	1	M	1	1.05
C20					0.93	O	1	0.93	0.89	W	0.91	0.89
C21					0.71	W	0.73	0.71	1	O	1	1.10
C22					0.90	O	1	0.90	1	O	1	1.01
C23					0.89	O	0.91	0.89	1	O	1	1.01
C24					1	M	1	1.08	0.93	W	0.93	0.93
C25					1	M	1	1.17	1	O	1	1.08
C26					0.88	W	0.92	0.88	1	O	1	1.01
C27					1	O	1	1.05	0.89	W	0.92	0.89
C28					0.87	W	0.88	0.87	0.92	W	1	0.92
C29					1	O	1	1.13	0.99	O	0.997	0.997

$\sum_{i=1}^{n}(\theta_i^{CRS}-1)/\sum_{i=1}^{n}(\theta_i^{VRS}-1)$			
	1.92	1.66	1.16
F Value*	Fail to reject CRS	Fail to reject CRS	Fail to reject CRS
$\sum_{i=1}^{n}(\theta_i^{CRS}-1)^2/\sum_{i=1}^{n}(\theta_i^{VRS}-1)^2$			
	1.79	1.63	1.34
F Value*	Fail to reject CRS	Fail to reject CRS	Fail to reject CRS

θ^{CRS} = Constant return to scale efficiency score, θ^{VRS} = Variable return to scale efficiency score, θ^{S} = Super efficiency efficiency score. Rank = Ranking of the caisses into Model (M), Weak (W) or Others (O) based on the contribution of the efficient caisses to the composites that determine the savings and possible additions of inefficient caisses.

Table 5 presents the input savings and additional outputs that inefficient caisses could attain if they adopted the production composites of their overall reference set. These savings and increased outputs are the difference between the caisse's composite (or projected) and real inputs and outputs. This composite is the linear combination of the real inputs and outputs of the caisse's overall reference set; the proportions corresponding to each caisse of the set are directly obtained from the DEA model.

Table 4: Level of Caisse in set 3 Operational Efficiency and Overall Reference Set Coefficients

These coefficients, which are automatically calculated by the DEA model, determine the level of inputs and outputs required to make inefficient caisses efficient. Caisses with a coefficient not equal to zero represent the overall reference set of the caisse being evaluated.

#	Eff. score	Reference set								
		C6	C7	C13	C17	C18	C19	C21	C23	C25
C1	0.83	0	0.45	0.12	1.12	0	0	0.05	0	0.40
C2	0.98	0	0.86	0	0.62	0	0.22	0.08	0	0
C3	0.72	0.14	0.26	0	0	0	0.06	0.62	0	0
C4	0.99	2.41	1.47	0	0	0	0.88	0	0	0
C5	0.95	0	0.38	0	0.48	0	0	0	0	0.10
C8	0.77	0	0.11	0	0	0	0.17	0.43	0	0
C9	0.96	0.62	0	0.20	0	0.13	0	0	0	0
C10	0.98	1.64	0	0	0	0	0.87	0	0	0
C11	0.97	0.83	0.55	0	0	0	0.04	0	0	0
C12	0.96	0.08	0.74	0.16	1.37	0	0	0	0	0.06
C14	0.92	0.10	0.25	0	0.1	0	0.19	0.19	0	0
C15	0.75	0	0.75	0	0.14	0	0	0	0	0
C16	0.96	1.52	0.34	0.08	0.54	0	0	0	0	0.42
C20	0.89	0.24	0.26	0.02	0.28	0	0	0.05	0	0
C24	0.93	0	0	0	1.13	0	0.24	0	0	0
C27	0.89	1.05	0.12	0	0.3	0.07	0	0	0.08	0
C28	0.93	0	0.17	0	0.44	0	0	0.01	0	0
C29	0.99	0.44	0	0	0.3	0	0.14	0.05	0	0

Overall, the 18 inefficient caisses could improve their efficiency by reducing their number of employees, their space, and their miscellaneous expenses without affecting the number of services offered.

Table 6 shows the aggregated results of all our three sets. The input savings and additional outputs are presented as a percentage of the actual values of the inputs and outputs. The percentages vary from one set to the other; but the greatest savings are in set 2. The results for the total of all three sets shows overall savings ranging from 8 to 12 per cent, depending on the input. Additional savings remain weak except for less complex operations. It must be remembered that although the percentages may seem low, they are calculated for all the caisses in the sets and only some of the caisses show significant inefficiencies. The usefulness of this method as a diagnostic tool and the possibility of identifying savings and significant additional outputs for some caisses are important managerial advantages. Indeed, DEA analysis, as management found, can be a useful complement to their traditional financial ratios analysis. Note that the most efficient caisses are not necessarily the most profitable, even if that is often the case. However, inefficient caisses can certainly increase their profitability by operating efficiently. We explore this avenue in more detail in the following sections by comparing the DEA results to the caisse profitability ratios and size. To do so, we first partition the caisses into "model," "weak" and "others" as described below. We then perform a multinomial logistic regression to examine whether the three group differ in term of profitability or size. Indeed, simple correlations test for comparing the DEA scores (bounded to zero and one) with unbounded profitability ratios or size variables could be misleading.

3.2 Partitioning the caisses into "model", "weak" and other

To discriminate between efficient units, many authors (Smith and Mayston, 1987; Charnes and Cooper, 1991; Boussofiane, Dyson and Thanassoulis, 1991) suggest ranking them according to

Table 5: Input saving and additional output that inefficient caisses in set 3 could obtain by adopting the production composites of their overall reference set.

These savings and increased outputs are the difference between the composite input-output obtain from caisse's reference set and its real inputs and outputs.

		Input						Output							
#	Eff. scores	FTEE	%	Space	%	Expenses	%	Out1	%	Out2	%	Out3	%	Out4	%
C1	0.8	5.9	17.0	2,726.8	17.0	239,670.7	28.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C2	1.0	1.1	2.0	464.5	3.0	21,049.9	2.0	0.0	0.0	0.0	0.0	1,096.3	4.0	0.0	0.0
C3	0.7	13.7	28.0	5,586.0	28.0	304,827.1	28.0	65,149.0	66.0	0.0	0.0	44.4	0.0	0.0	0.0
C4	1.0	7.9	7.0	511.2	1.0	24,473.9	1.0	26,249.6	5.0	28,698.7	1.0	0.0	0.0	0.0	0.0
C5	1.0	1.0	5.0	7,186.3	46.0	70,839.0	14.0	0.0	0.0	3,376.3	1.0	0.0	0.0	0.0	0.0
C8	0.8	7.5	23.0	4,403.0	30.0	159,599.6	23.0	48,109.0	68.0	0.0	0.0	3.2	0.0	0.0	0.0
C9	1.0	1.7	8.0	246.0	4.0	18,400.0	4.0	0.0	0.0	36,867.9	6.0	0.0	0.0	14,853.9	14.0
C10	1.0	2.8	5.0	351.2	2.0	16,384.6	2.0	32,020.5	16.0	204,176.5	17.0	0.0	0.0	31,574.5	15.0
C11	1.0	2.2	8.0	305.2	3.0	16,128.3	3.0	20,651.1	18.0	0.0	0.0	2,827.4	22.0	0.0	0.0
C12	1.0	2.2	4.0	816.8	4.0	46,664.0	4.0	0.0	0.0	63,501.7	4.0	0.0	0.0	0.0	0.0
C14	0.9	2.1	8.0	1,752.6	16.0	41,136.4	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C15	0.8	7.8	25.0	3,211.3	26.0	146,923.1	25.0	0.0	0.0	11,176.6	2.0	956.9	8.0	50,917.6	51.0
C16	1.0	2.1	4.0	595.8	4.0	43,395.5	4.0	0.0	0.0	49,353.5	3.0	0.0	0.0	0.0	0.0
C20	0.9	2.1	11.0	768.2	11.0	43,441.1	11.0	6,500.4	7.0	0.0	0.0	0.0	0.0	0.0	0.0
C24	0.9	2.1	7.0	1,998.7	16.0	43,684.1	7.0	70,115.7	81.0	0.0	0.0	3,013.1	22.0	1,406.4	1.0
C27	0.9	3.2	11.0	998.6	11.0	63,347.3	11.0	0.0	0.0	0.0	0.0	232.4	1.0	0.0	0.0
C28	0.9	0.9	7.0	1,441.4	23.0	25,199.0	9.0	0.0	0.0	0.0	0.0	929.7	13.0	0.0	0.0
C29	1.0	0.1	0.0	21.0	0.0	1,171.4	0.0	21,364.1	33.0	0.0	0.0	1,444.7	17.0	0.0	0.0
Total		66.5		33,384.5		1,326,335.0		290,159.3		397,151.2		10,548.0		98,752.4	

Table 6: Percentage of Input Savings and of Possible Additional Outputs for All Sets

These savings and additional outputs are the difference between the composite of the credit union's inputs and outputs, based on its reference set and its current inputs and outputs. The values are expressed as a percentage in relation to the current situation and the total is calculated for the number of transactions.

	Set 1	Set 2	Set 3	Total for 3 sets
FTEE	8.5	13	6.6	8.3
Sq. ft.	12	20	8.7	12
Smisc.	9.5	14	6.8	8.7
Output 1	2.1	5.8	6.5	6.1
Output 2	1.5	0.9	1.4	1.3
Output 3	0.9	1.5	2.0	1.8
Output 4	3.3	8.1	1.9	3.2

the number of times they appear in inefficient units reference sets. However, this approach does not account for the relative importance of the efficient units as referents to the inefficient one. In this paper, we follow another approach. For each set, we identified the efficient caisses contributing the most to the composites that determine the savings and possible additions of inefficient caisses. In each set, 4 caisses stood out from this point of view. We describe them as "models" For inefficient caisses, a ranking was established based on their possible input savings and output additions. The lower half of all caisses in each set were described as "weak". Set 1 has 5 of these and sets 2 and 3 have 12. The caisses that are neither "model" nor "weak" are defined as "others". Note that "model" caisses are, by definition, efficient but that certain "other" caisses are too. In general, these are caisses that are efficient but not a significant part of the reference sets. All efficient caisses are "model" or "others".

Note that there exists other approaches to discriminate among efficient units, such as the cross efficiency (Sexton et al., 1986, and Doyle and Green, 1994), the super efficiency (Andersen and Petersen, 1993) and the global efficiency approaches (Despotis, 2002). However, considering the two very different types of output selected and the nature of the inputs, we think that such partitioning is reasonable and allows a comparison of the results of efficiency with other caisse parameters, especially profits[1].

3.3 Comparisons with profitability and size measures

Ultimately, caisses use surpluses to determine profitability and efficiency. For a given credit union, operational profit is essentially the difference between operations-based income earned in a period (including that from new assets) and expenditures for the same period. Total profit considers all revenues, even if they come from assets generated during prior periods. Determining the boundary is therefore not easy because parameters reflect past as well as current performance, even for operational profits. A credit union's history, its age and its past management have a strong bearing on total profits. Table 7 presents descriptive statistics of credit union total number of transactions, assets and number of members and profits calculated in terms of dollars per 100 dollars of assets.

The profitability measures provide a strict ranking of caisses and are too often interpreted as a reflection of their operational efficiency as well as their financial performance, for example, in terms of credit or investments. It should be noted that theses financial ratios do not differ signif-

1 However, we have also compute the super efficiency DEA scores for the three sets of caisses. As shown in Table 3, in most cases, the "Model" caisses have the highest super efficiency score.

Table 7: Descriptive Statistics - Credit Union Profits

Statistics on both types of profits: operations and total, for all three sets in $ per $100 of assets

	Set 1		Set 2		Set 3	
	Operations	Total	Operations	Total	Operations	Total
Minimum	0.27	0.08	-1.69	1.63	1.51	1.41
Maximum	1.31	1.56	1.15	1.55	1.20	1.61
Median	0.77	1.18	0.46	0.84	0.47	0.67
Total	10.68	16.80	12.52	23.42	11.14	20.56
Mean	0.71	1.12	0.43	0.81	0.38	0.71
Std. dev.	0.40	0.42	0.52	0.60	0.46	0.51

icantly for the three sets, except that profits for set 1 (the small-size one) are on average higher. The negative minima of operating and total profit come from a single credit union in each of the three sets. For sets 2 and 3, these caisses are inefficient whereas the credit union showing the least profit in set 1 is to be found DEA-efficient. The latter result leads one to think operational efficiency as measured by the DEA analysis do not necessarily leads to more profit.

A graphic presentation may be the best way to visualize possible relationships. For each of the sets, graphics of the usual measures for caisses were therefore drawn, showing how the "model," "weak" and "other" ones compare using these measures. Figure 1 therefore shows, set 1 to 3, four charts in which the usual measures are classified in decreasing order.

For the three sets, the charts show clearly that the "model" caisses are never the largest in terms of assets or number of members. "Weak" and "other" caisses are of various sizes. For the two types of profits, the "model" caisses are never the weakest and the highest profits are often those of the "model" caisses. The "weak" and "other" caisses show no significant relationship.

We go further by performing a multinomial logistic regression to verify the existence of any statistical relation between DEA efficiency and "caisse" size and usual profitability measures.

For set 2 (Table 8, Panel B), only the coefficient associated with the variable members ("other" vs. "weak") and asset ("other vs. "weak") are statistically significant. This means that caisses classified as "other" are in general larger in terms of their number of members and assets than "weak" caisses. For sets 1 and 3, as shown in Table 8 (Panel A and C), none of these variables (total and operating profits, number of transactions, number of members) are statistically significant at the conventional 5% level. These results thus indicate that our distinction between "model," "weak" and "other" does not seem to correspond to information given by the usual measures. More specifically, when looking at profits, there do not seem to be any significant differences in terms of credit union efficiency distribution.

Overall, it is important to note that certain caisses (e.g. set 3) have high total and operational profits but are considered "weak" in terms of efficiency and therefore candidates for significant improvements. All of these facts clearly show that accounting profits could be an incomplete, or worse, a misleading or shortsighted measure of caisses' operational efficiency. Moreover, the many input-output ratios calculated by caisses do not provide them with a broad picture of the situation nor, obviously, of possible input improvements.

4. CONCLUSION

In this study the DEA method was used to analyze the relative efficiency of a group of 73 independent caisses within one federation of the "Caisses Populaires Desjardins" in Québec, after dividing them into three sets. The results are consistent and address management concerns. The DEA method provides useful and complementary information to that obtainable from typical ratio analyses, which are in fact ill-suited for simultaneously considering many inputs and outputs.

Figure 1: Various charts relating the DEA-efficiency scores with caisses' size and profit variables

SET 1

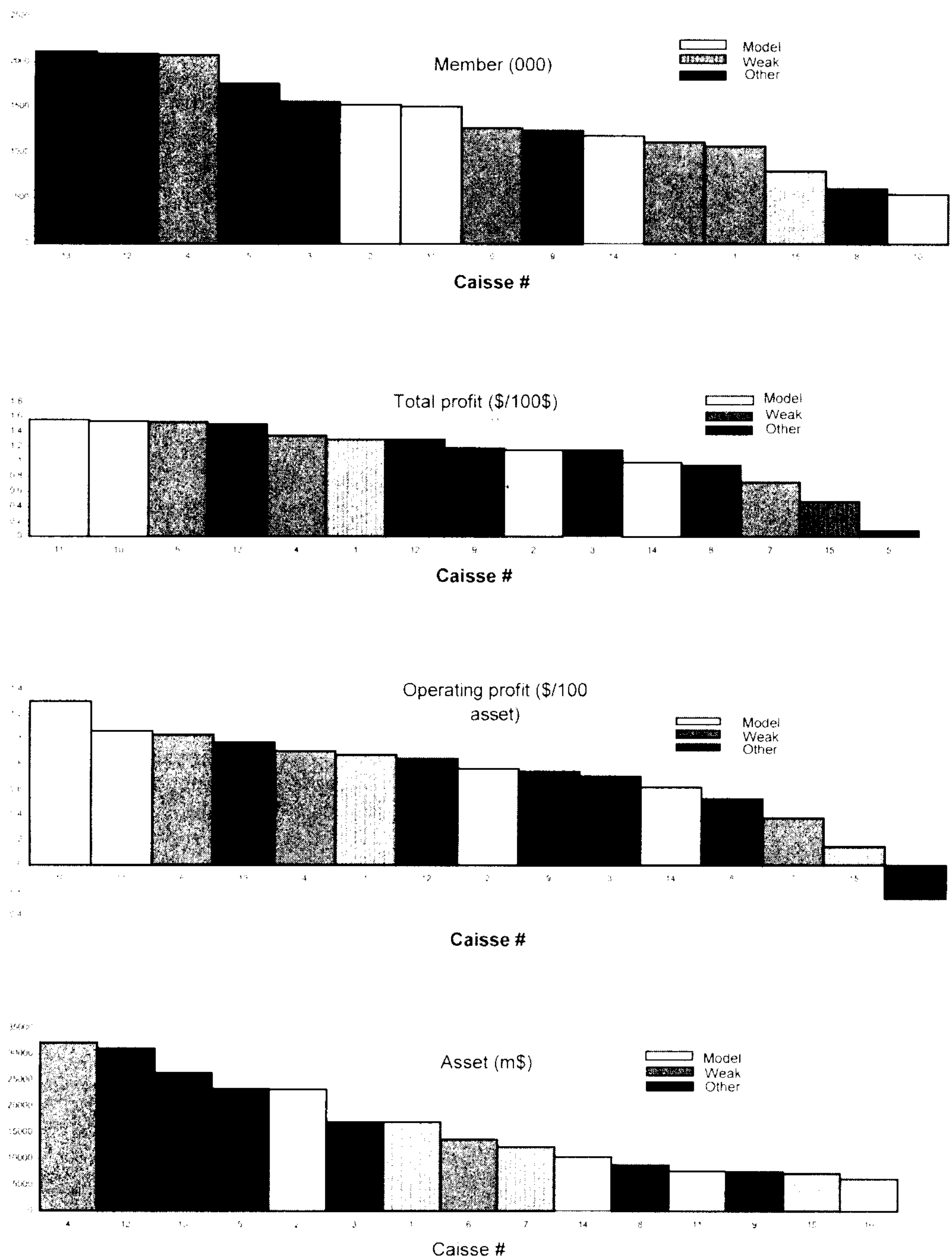

Figure 1: (*Continued*)

SET 2

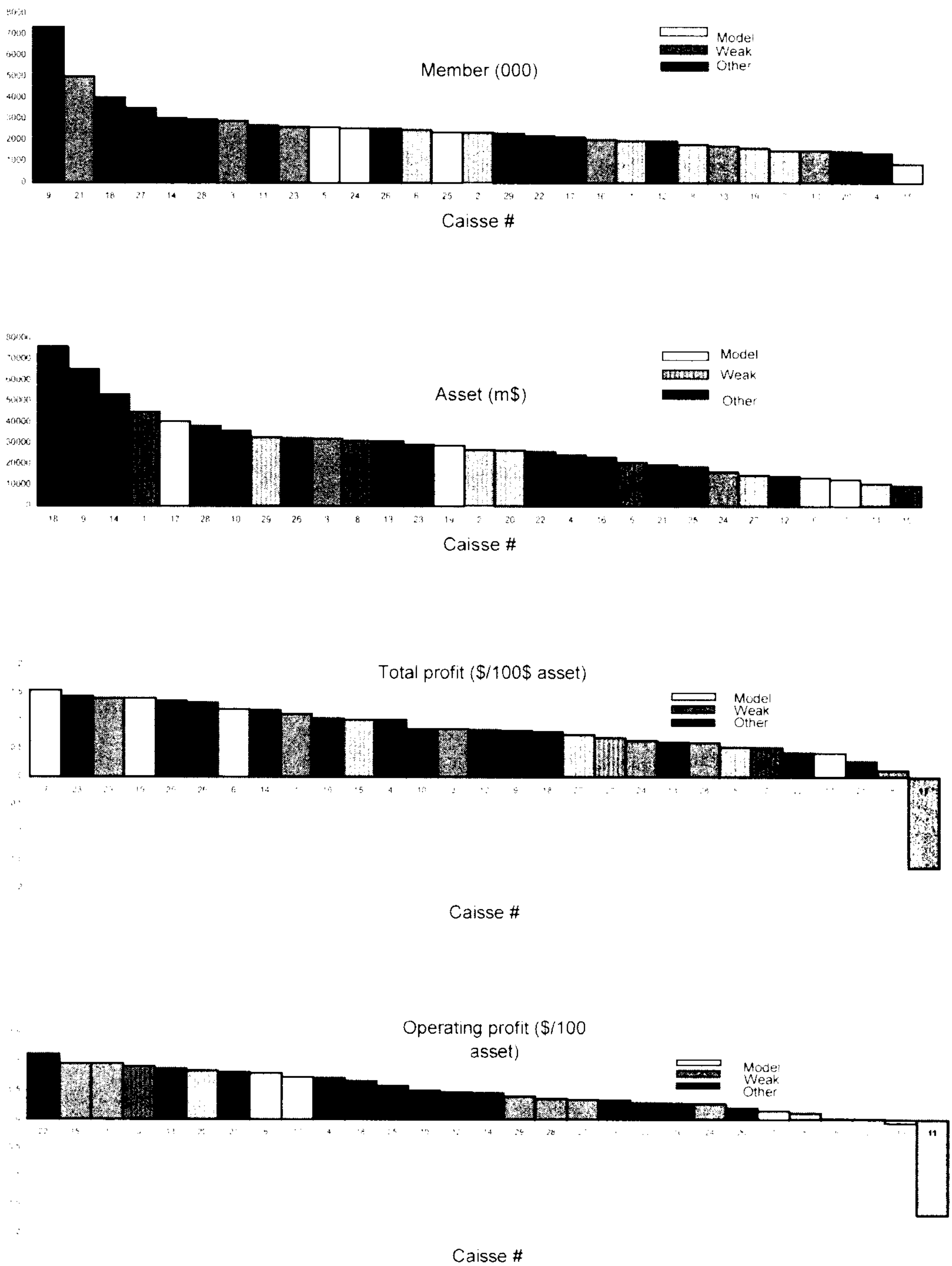

Figure 1: *(Concluded)*

SET 3

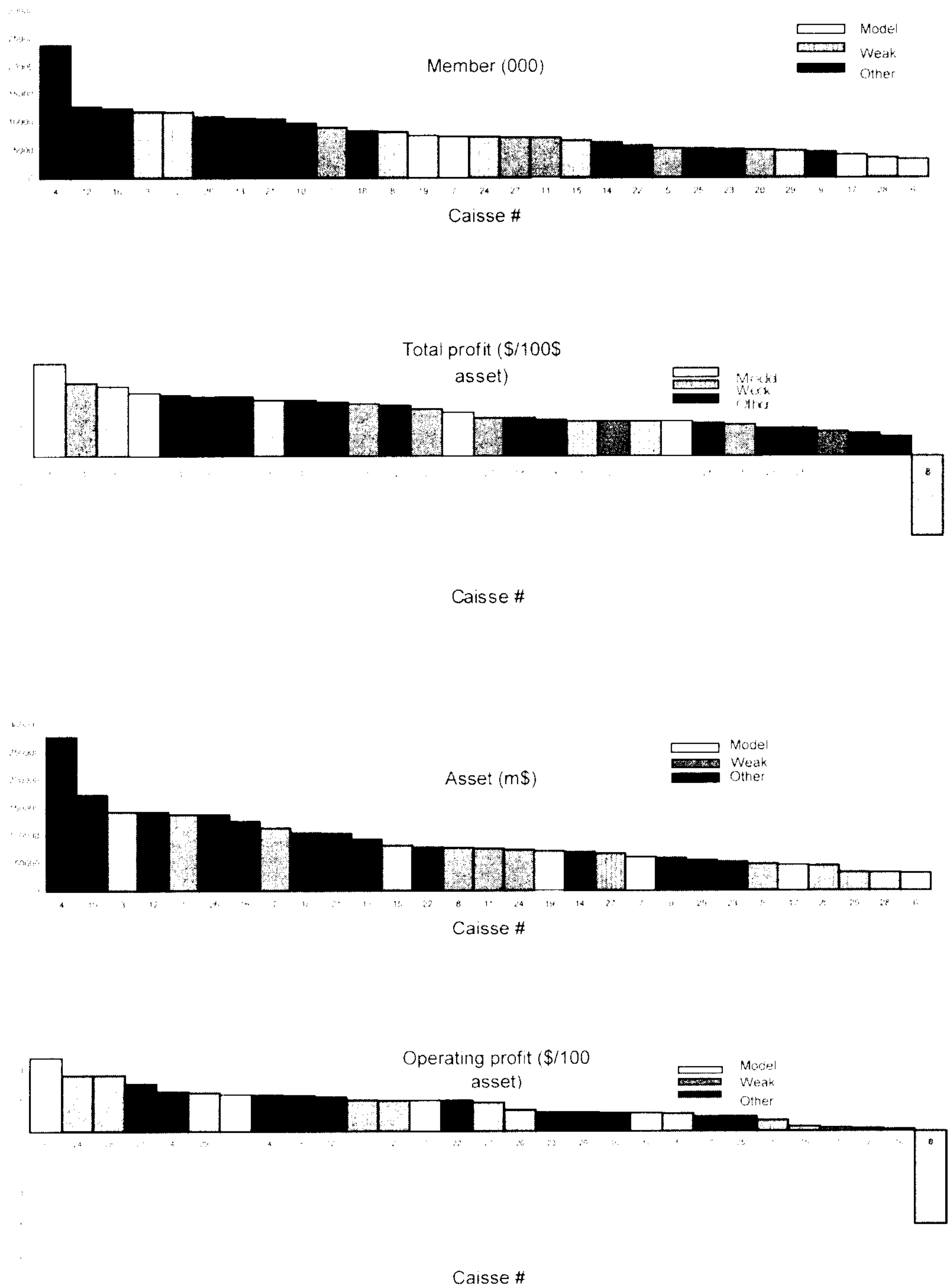

Table 8

Panel A: (set 1)

Variable	Comparison	Logit Estimate	Std. Error	t-value	P > |t|
Constant	1/0	-1.228	1.382	0.01	0.993
	2/0	0.551	1.224	0.00	0.996
Members	1/0	0.196	23.920	0.01	0.993
	2/0	0.174	41.842	0.00	0.997
Assets	1/0	0.007	0.931	0.01	0.994
	2/0	-0.009	1.684	0.01	0.996
Total profits	1/0	3.813	4.303	0.01	0.993
	2/0	-2.605	4.937	-0.01	0.996
Operating profits	1/0	-4.595	5.193	-0.01	0.993
	2/0	3.163	5.775	0.01	0.996

Pseudo R-squared: 35.6%

Panel B: set 2

Variable	Companison	Logit Estimate	Std. Error	t-value	P > |t|
Constant	1/0	-4.184	2.884	1.45	0.147
	2/0	-3.586	4.755	0.75	0.451
Members	1/0	0.003	0.002	2.20	0.028
	2/0	-0.002	0.002	-1.13	0.257
Assets	1/0	-0.0002	0.0001	2.15	0.031
	2/0	0.0001	0.0001	1.06	0.287
Total profits	1/0	7.663	6.739	1.14	0.256
	2/0	4.209	9.802	0.43	0.668
Operating profits	1/0	-8.941	7.734	1.16	0.248
	2/0	0.784	11.500	0.07	0.946

Pseudo R-squared: 44.1 %

Panel C: Set 3

Variable	Comparison	Logit Estimate	Std. Error	t-value	p > |t|
Constante	1/0	0.652	1.890	0.35	0.730
	2/0	2.523	3.338	0.76	0.450
Members	1/0	0.0001	0.0004	0.49	0.627
	2/0	0.0007	0.0009	0.84	0.401
Assets	1/0	0.00003	0.0001	1.09	0.276
	2/0	-0.0001	0.0001	-1.18	0.239
Total profits	1/0	-3.4637	5.601	-0.62	0.536
	2/0	11.288	10.668	1.06	0.290
Operating profit	1/0	4.378	6.184	0.71	0.479
	2/0	-10.794	12.280	0.88	0.379

Pseudo R-squared: 33.59%

This method and the partitioning of decision-making units into different sets allows managers to better identify the least efficient areas of their operations, considering the similarity of their decision-making unit to other units in the same set.

Comparison was also made between the DEA efficiency scores and the caisse profitability measures using multinomial logistic regression. To do so, the efficient caisses were classified according to their contribution to the reference set of inefficient caisses. Overall, it was shown that accounting profits could be an incomplete, or worse, a misleading or short-sighted measure of the caisses' operational efficiency. Indeed, certain caisses are described as "weak" and therefore candidates for significant improvements but still display higher total and operational profits than some "model" caisses.

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