# Evaluating the Financial Performance of Bank Branches


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**Abstract**

In this paper we evaluate the financial performance of virtually all of the branch offices of a large European savings bank for a recent six-month accounting period. We employ a complementary pair of nonparametric techniques to evaluate their financial performance, in terms of their ability to conserve on the expenses they incur in the process of building their customer bases and providing customer services valued by the bank. We find substantial variation in the ability of branch offices to perform this task, and substantial agreement on the identity of the branches at the bottom of the performance distribution. We then employ parametric techniques to determine that the list of indicators on which their financial performance is currently evaluated can be substantially reduced without statistically significant loss of information to bank management. Both findings suggest ways in which the bank can increase the profitability of its branch network.



Keywords: banking, performance indicators, efficiency

JEL codes: D20, G21, C60

# CONTENTS

## 1. Introduction

We examine the performance of a large European savings bank that currently operates a network of approximately 600 branch offices. Bank management collects and analyzes information on several expense, revenue and customer indicators from each branch office on a regular basis. Management's objective is to evaluate the overall financial performance of each branch office, by monitoring branch office expenses, revenues and customer bases with an eye toward maximizing the profit the branch network returns to the bank.

Management has provided us with data covering over 20 expense, revenue and customer indicators for each branch office in its network for a recent six-month accounting period. Our objectives are to build a consistent data base consisting of several expense and service indicators, to evaluate the overall financial performance of each branch office, and to evaluate the information content of the data base itself.

The value of having an independent evaluation of the overall financial performance of branch offices is that our approach is model-based, in contrast to the descriptive approach adopted by bank management. Our model-based approach enables us to identify branch offices that excel, and those that are less successful, at conserving on expenses while generating revenues. Identifying branch offices at the top and the bottom of the overall financial performance distribution is an essential first step in a process of improving the overall performance of the branch network. Branch offices appearing at the bottom of the distribution, or branch offices whose overall financial performance fails to meet a predetermined minimum standard, may be candidates for remedial action, or perhaps closure. Bonuses may be assigned to branch offices at the top of the distribution, or to branch offices whose overall financial performance surpasses a predetermined standard. In addition, high-performing branch offices may serve as instructive role models for low-performing branch offices.

The value of having an independent evaluation of the data base itself is that it may be possible to characterize the information content of each indicator that management currently uses to evaluate the overall financial performance of branch offices. Some indicators are inevitably influential, and should be retained, while others may be superfluous, and are candidates for deletion. By conducting a series of statistical tests, we are able to characterize individual indicators as being influential or superfluous. This enables us to suggest ways in which the magnitude of the data base can be reduced, without sacrificing or distorting information that would be useful to bank management. If it is possible to reduce the number of indicators on which the branch office performance evaluation is based, bank profit is doubly enhanced, through reduced bank monitoring costs and also through reduced branch office compliance costs.

Our empirical analysis of the overall financial performance of branch offices is based on a complementary pair of nonparametric mathematical programming techniques. Both have been used to analyze the performance of financial institutions, including bank branches, although never before in tandem. Data envelopment analysis (DEA) (Charnes *et al.* (1978)) is a linear programming technique developed specifically for the purpose of evaluating and comparing the performance of a collection of comparable organizations. Free disposal hull (FDH) analysis (Deprins *et al*. (1984)) is a closely related mixed integer programming technique developed for the same purpose.[1] Both techniques have the ability to evaluate and compare the performance of organizations that use several resources to provide several services; this makes them particularly useful in a financial services context, since branch offices incur a variety of expenses in the provision of a wide range of financial services. Neither technique requires information on the prices of the resources organizations consume or of the services they provide; this is also useful in a financial services context, since it is difficult to derive prices of all the services branch offices offer their customers.[2] Using a pair of complementary analytical techniques is useful for two reasons. First, it is always desirable to have a supplementary technique (in our case FDH) to provide a validation check on the results provided by the primary technique (in our case DEA). To the extent that primary findings are confirmed by supplementary findings, the confidence of bank management in the validity of the findings is enhanced.[3] Second, DEA and FDH have complementary strengths that will be discussed below.

The paper is organized as follows. In Section 2 we discuss the data base we have constructed from the data originally provided to us by bank management. Our data base consists of four expense indicators, three revenue indicators, three customer base indicators, and a pair of conventional financial ratios, for 573 branch offices for a recent six-month accounting period. In Section 3 we discuss the two analytical techniques we use to analyze the overall financial performance of the branch offices. We also discuss the statistical techniques we use to analyze the information content of the data base itself. In Section 4 we present and discuss our empirical findings. Our first finding is that the complete list of indicators on which the branch office performance evaluation is initially based can be reduced considerably, with no statistically significant loss of information to bank management. Our second finding is that considerable variation in overall financial performance exists among the bank's branch offices, and that reducing this variation by improving the performance of the weakest branch offices would return increased profit to the bank. Section 5 concludes with a summary of our findings and some suggestions for future work.

## 2. The Branch Office Financial Performance Data

Management has provided us with a list of over 20 indicators on which the bank bases its domestic branch office financial performance evaluation. After eliminating indicators for which fewer than 500 branch offices reported values, we ended up with complete information on 12 indicators for 573 branch offices. Management considered these 12 indicators as a good representation of the complete set of indicators. Four of the indicators are expense items (personnel expense, other operating expense, deposit interest expense and the value of delinquencies). One indicator is a fairly comprehensive revenue item (interest income from loans, credit cards and other sources). Three indicators characterize the customer base (the number of customers, the number of customers classified as “regular” (having at least a minimum amount of money in a deposit account), and the number of customers classified as having a high income). Two indicators are measures of size (the value of deposits and the value of assets). The final two indicators are conventional financial ratios (return on assets (the ratio of interest income to the value of assets) and profitability (the ratio of interest income less the four expense items to the value of assets)).

The list of 12 indicators appears in Table 1. For purposes of subsequent analysis, we categorize the indicators into two groups: resources to be conserved (the four expense indicators) and services to be expanded (the eight remaining indicators). For reasons of confidentiality we do not provide the corresponding descriptive statistics, although we can report that coefficients of variation range from 0.22 (return on assets) to 4.24 (profitability), and that the dispersion in branch office size is enormous, as is the dispersion in branch office performance as measured by the two financial ratios. However these two indicators are partial, and short term, and may not convey an accurate picture of the long term financial viability of the branch offices. What is needed is a picture of the *overall* financial performance of branch offices, as measured by their ability to convert the resources at their disposal into services valued by bank management, and this is not provided by the usual variable-by-variable information. An overall picture of the financial performance of branch offices requires that the information contained in the indicators listed in Table 1 be aggregated into a single comprehensive performance indicator. A pair of comprehensive performance indicators is developed in the next Section.

## 3. The Analytical Techniques

In this Section we describe the analytical techniques we use to evaluate the overall financial performance of the branch offices, and to evaluate the information content of the underlying data base. We begin with a description of the analytical techniques we use to evaluate the overall financial performance of the branch offices.

### *3.1 DEA and FDH*

We refer to the list of indicators discussed in Section 2 and summarized in Table 1. Our objective is to aggregate the 12 financial indicators in such a way that we generate an overall performance evaluation for each branch office. DEA generates such a performance evaluation, as does FDH. The two techniques do not generally assign the same performance evaluation to each branch office, but if the two performance rankings are generally consistent, this provides a measure of confidence in each ranking.

The overall financial performance of branch offices can be evaluated in either of two ways: in terms of their ability to minimize resource utilization in the provision of a given amount of services, or in terms of their ability to maximize service provision from a given amount of resources. Both approaches are broadly consistent with the general objective of bank management of maximizing network profit. For primarily technical reasons, we adopt the former approach, and so we evaluate the overall financial performance of branch offices on the basis of their ability to minimize resource use in the provision of a given amount of services. In our evaluation we identify resource use with the four expense indicators, and we identify service provision with the eight revenue indicators.[4]

Let $y^j = (y_1^j,...,y_8^j) \geq 0$ denote a nonnegative vector of eight services provided by branch office j, and let $x^j = (x_1^j,...,x_4^j) \geq 0$ denote a nonnegative vector of four resources utilized by branch office j, with j = 1,...,573. Then an evaluation of the overall financial performance of branch office j is provided by the solution to the Banker *et al*. (1984) DEA envelopment problem

$$\min_{\theta,\lambda_k} \theta \quad \text{subject to} \quad \begin{aligned} \theta x_i^j &\geq \Sigma_k \lambda_k x_i^k & i &= 1,...,4 \\ \Sigma_k \lambda_k y_i^k &\geq y_i^j & i &= 1,...,8 \\ \lambda_k &\geq 0 & k &= 1,...,573 \\ \Sigma_k \lambda_k &= 1. \end{aligned}$$

This problem, known as the BCC model, is solved 573 times, once for each branch office in the sample. The output of the exercise is a set of 573 optimal values of $[\theta, \lambda = (\lambda_1,...,\lambda_k,...,\lambda_{573})]$ for each branch office. (See again footnote 3.)

The objective in the problem is to radially contract the resource vector utilized by branch office j as much as possible. The constraints of the problem limit the potential contraction by requiring that $(\theta x^j, y^j)$ not outperform best practice observed in the sample of 573 branch offices. The optimal value of $\theta \in (0,1]$ provides an overall financial performance indicator, incorporating performance across all 12 indicators. Optimal $\theta = 1$ suggests that branch office j is operating at best practice, since it is not possible to contract its resource vector without violating best practice standards in the sample.[5] Optimal $\theta < 1$ suggests that branch office j is operating at less than best practice, since it is possible to contract its resource vector equiproportionately to $\theta x^j$, or by $100 \bullet (1 - \theta)$%, without violating best practice standards in the sample. The smaller the value of optimal $\theta$, the less efficient a branch office is in conserving expenses in the generation of revenues, and the more room it has for improvement.

The nonzero optimal values of $\lambda_k$, k = 1,...,573, identify the best practice branch offices to which branch office j is compared. If more than one optimal $\lambda_k > 0$, the performance of branch office j is evaluated relative to the performance of an unobserved convex combination of these best practice branch offices. It is also possible to evaluate the performance of branch office j relative to that of a single best practice branch office, by adding to the DEA constraint set the additional requirement that $\lambda_k \in \{0,1\}$, k = 1,...,573. This converts the DEA performance evaluation problem to an FDH performance evaluation problem. Together with the DEA requirements that $\lambda_k \geq 0$, k = 1,...,573, and that $\Sigma_k \lambda_k = 1$, the FDH constraint $\lambda_k \in \{0,1\}$, k = 1,...,573, forces exactly one optimal value of $\lambda_k$ to be positive, and to attain a value of unity, with all other optimal values $\lambda_m = 0$, $m \neq k$. This leads to the evaluation of the performance of branch office j relative to that of exactly one best practice branch office, the one having a service mix most similar to that of branch office j. Like the DEA exercise, the FDH evaluation is conducted 573 times, once for each branch office in the sample.[6]

DEA and FDH generate different optimal values of $\theta$ for each branch office. Since the FDH programming problem contains one more constraint than the DEA programming problem, the two sets of optimal performance evaluations satisfy the inequalities $\theta_j^{DEA} \leq \theta_j^{FDH} \leq 1$, j = 1,...,573. Since DEA performance evaluations are relatively low, interest naturally focuses on those branch offices at the top of the DEA performance distribution; these branch offices excel even when standards are relatively high. Since FDH performance evaluations are relatively high, interest focuses on the bottom of the FDH performance distribution; these branch offices lag behind, even when standards are relatively lax. In addition, confidence in the performance evaluation exercise is enhanced if the two distributions are similar, apart from the differences in their means.

FDH provides for each branch office j a radial performance indicator $\theta \leq 1$, and identifies a single best practice role model identified by $\lambda_k = 1$. This single best practice role model is one of possibly many branch offices that dominate branch office j. Branch office j is said to be *dominated* by all branch offices indexed m and having $y_i^m \geq y_i^j$, i = 1,...,8, and $x_i^m \leq x_i^j$, i = 1,...,4. To be dominated by many branch offices may be considered worse than being dominated by few branch offices, although it does allow for more role models from which to learn. Branch office j is said to dominate all branch offices indexed m if the direction of the above inequalities is reversed. Dominating many branch offices is preferred to dominating few branch offices. Dominance relationships identified by FDH are complementary information to efficiency information provided by both DEA and FDH. Dominance analysis has the additional advantage of being non-oriented; the information it provides is independent of the resource conserving orientation of the DEA and FDH models we use to measure financial performance efficiency.[7]

### *3.2 Evaluating the Information Content of the Data Set*

Thus far the strategy for developing an overall financial performance evaluation of branch offices has been predicated on the assumption that all 12 expense and revenue indicators are included in the analysis. However it is possible that not all 12 indicators have the same information content. Some may be influential, in the sense that deleting any one of them would result in a significantly different performance distribution. Others may be superfluous, in the sense that deleting any one of them would generate essentially the same performance distribution. The objective of this Section is to determine the minimal subset of influential indicators upon which to base the overall financial performance evaluation of the branch offices. To that end we summarize a variable deletion procedure developed by Pastor *et al.* (2002).

We begin with a DEA performance analysis of all 573 branch offices based on all 12 resource and service indicators, DEA being our primary performance evaluation technique. We then ask if the performance of some branch offices, as measured by their optimal values of $\theta$, declines more dramatically than that of other branch offices when a particular indicator (or set of indicators) is deleted. If it does, the performance distribution is distorted by the deletion of that indicator, a significant amount of managerially useful information would be lost, the candidate indicator for deletion is deemed "influential," and it is not deleted. If the performance distribution does not change in a substantial way, an insignificant amount of managerially useful information would be sacrificed, the candidate indicator for deletion is deemed "superfluous" and deleted, and potentially large resource savings can be realized. This procedure continues until no indicator (or set of indicators) can be found whose deletion would not seriously distort the performance distribution.

The surviving indicators then form the basis for a second DEA performance evaluation, and an initial FDH performance evaluation.

Somewhat more formally, let $0 < \rho_j = \theta_j^r / \theta_j^t \leq 1$, j = 1,...,573, be a vector of ratios of efficiency scores obtained from a reduced set of r < 12 indicators to the efficiency scores obtained from the full set of t = 12 indicators, for each of 573 branch offices. The values of $\rho_j$ constitute a sample drawn from a distribution $\Psi = (\Psi_1,...,\Psi_j,...,\Psi_{573})$. We want to determine if values of $\Psi$ that differ from unity in a sufficiently large magnitude are likely enough to assert that the deleted indicator (or set of indicators) is influential. We can solve this problem by determining whether there exists sufficient statistical evidence to assert that $P[\Psi < \rho^o] > p^o$, $\rho^o$ being a preassigned value (say, 0.95) and $p^o$ being some satisfactory level of probability (say, 5%). A test of the hypothesis is based on the binomial distribution $B(572, p^o)$. The reason for considering 572 instead of 573 is that at least one of the efficient units in the model with all the indicators will remain efficient in all models with fewer indicators. The statistic we consider is T = number of units with $\rho < \rho^o$. The null hypothesis, which states that the set of efficiency scores of the initial and the reduced model are indistinguishable, is rejected if the p-value of the binomial distribution corresponding to T is high (or, equivalently, if T is a large number). In that case, we conclude that the candidate indicator (or set of indicators) is influential, because the reduced set of indicators explains less than $\rho^o$% of the total efficiency for more than $p^o$% of the branch offices. If the hypothesis can be rejected, we conclude that the candidate indicator (or set of indicators) is superfluous, because the reduced set of indicators explains more than $\rho^o$% of the total efficiency for more than $(1 - p^o)$% of the branch offices. One final point is worth mentioning. The binomial test is applied to a sample that is not i.i.d., and the two parameters are fixed at $(\rho^o,p^o)$. However by means of a Monte Carlo simulation study Sirvent *et al.* (2001) have determined that the test performs reasonably well for specific pairs of values of the parameters, outperforming the power of other known tests.

### *3.3. The Curse of Dimensionality*

In the introduction we noted that the elimination of superfluous indicators would enable bank management to reduce the monitoring and compliance costs associated with the branch office performance evaluation exercise. As Simar and Wilson (2001) note, there also is a compelling technical reason for doing so. The DEA and FDH efficiency estimators are biased, although they are consistent. However their rates of convergence vary inversely with the number of indicators included in the performance evaluation; this is the curse of dimensionality that plagues nonparametric estimators.[8] Confidence in the performance evaluation would thereby be enhanced not just by concordance of the DEA and FDH efficiency rankings, but also by increased rates of convergence brought about by the elimination of superfluous indicators.

## 4. Empirical Findings

We begin with a discussion of the results of applying our primary analytical technique, DEA, to the entire list of 12 indicators. We use these results as a benchmark against which to compare subsequent results obtained from shorter lists of indicators. We continue by discussing the results of applying the variable deletion test to the 12 indicator data set, using the DEA efficiency scores. Finally, when we have obtained a minimal fully informative list of indicators, we recalculate DEA efficiency scores, and we calculate FDH efficiency scores and dominance relationships. Our evaluation of the overall financial performance of the branch offices is based on the DEA and FDH results applied to the reduced list of indicators.

### *4.1 Initial DEA Results*

We have run the DEA linear programming problem for 573 branch offices, using the complete list of indicators containing four resources and eight services. Results are summarized by the frequency distribution of DEA efficiency scores which appears in the first column of Table 2. Roughly 28% (158 of 573) of all branch offices are best practice offices, being incapable of a radial contraction of their expenditure vectors without violating best practice observed in the sample.[9] The remaining 72% of branch offices have financial performance efficiencies ranging down to 0.546, implying that the least efficient offices are capable of a 45% reduction in their expenditures without sacrificing service provision. The bottom decile of the performance distribution is capable, on average, of a 37% reduction in expenditure without sacrificing service provision.

### *4.2 Variable Deletion Test Results*

Bank management has classified the eight service indicators into three categories. The service category deemed most important consists of the primary revenue indicator (interest income from loans, credit cards and other sources) and the two size indicators (the value of deposits and the value of assets). A somewhat less important service category consists of the three indicators characterizing the customer base (the number of customers, the number of regular customers, and the number of high-income customers). A third, still less important, service category consists of the two financial ratios (return on assets and profitability).

Referring back to the variable deletion procedure discussed in Section 3.2, we wish to test the hypothesis that an evaluation of the overall financial performance of branch offices based on a reduced number of service categories provides essentially the same information as an evaluation based on all three service categories. Testing this hypothesis requires solving the DEA linear programming problem for all 573 branch offices several times. We have already solved the problem using all three service categories. The next step is to solve the same problem using only the first two service categories, after which we solve the same problem using only the first and third service categories. Then we conduct two tests of the hypothesis that either the second service category or the third service category can be deleted without statistically significant loss of information. If we reject both hypotheses, the performance evaluation is based on all three service categories, because all three service categories turn out to be influential. If we fail to reject both hypotheses, the performance evaluation is based on just the first service category, because the second and third service categories are deemed superfluous. If we reject one hypothesis and fail to reject the other, the performance evaluation is based on two influential service categories, the first service category and one of the two remaining service categories. Finally, once we are down to a minimal number of influential service categories, we repeat the procedure in an effort to eliminate superfluous resources, and superfluous services within each service category. Whatever the outcome of the hypothesis testing procedure, we are confident that the final financial performance evaluation is based on the smallest number of resources and services which can be used without statistically significant loss of managerially useful information.

We begin by testing the hypothesis that the third service category is superfluous, on the grounds that the two financial ratios are consequences, rather than determinants, of the overall financial performance of branch offices. We are unable to reject this hypothesis; the two frequency distributions of branch office financial performance efficiencies are virtually identical, and statistically indistinguishable. The evaluation of overall financial performance based on all three service categories generates 158 efficient branch offices, with the efficiencies of the remaining 415 branch offices contained in the range [1, 0.546]. The evaluation of overall financial performance based on the first two service categories generates 150 efficient branch offices, with the remaining 423 branch offices contained in the range [1, 0.546]. Only three branch offices have $\rho_j = \theta_j^{10}/\theta_j^{12} < \rho^o = 0.95$. We conclude that the two financial ratios are superfluous to an evaluation of the overall financial efficiency of branch offices.[10]

We next test the hypothesis that the second service category is superfluous, on the grounds that customer characteristics are not direct indicators of financial performance. We are able to reject this hypothesis; deleting customer characteristics alters the frequency distribution of branch office financial performance efficiencies to a statistically significant degree. 190 branch offices have $\rho_j = \theta_j^{7}/\theta_j^{10} < \rho^o = 0.95$. Since elimination of the three customer characteristics indicators would result in a significant loss of managerially useful information, this service category is not deleted. At this point in the hypothesis testing procedure, we have succeeded in reducing the list of indicators from 12 to 10.[11]

We next test the hypothesis that any single resource, or any single remaining service, can be deleted without statistically significant loss of information. We are unable to delete any of the four resources; deleting any resource would significantly alter the frequency distribution of branch office financial performance efficiencies, thereby leading to a loss of managerially useful information.[12] We are, however, able to delete two services, one from each remaining service category, without statistically significant loss of information. The two services we are able to delete are interest income (from the first category), and the number of regular clients (from the second category).[13] We were rather surprised when we discovered that it was practically equivalent to delete the number of clients instead of the number of regular clients. In any DEA model formulated as a linear program, two outputs are equivalent if either one of them can be expressed as an affine combination of the other with positive scale factor. A linear regression with the number of clients as the independent variable and the number of regular clients as dependent yields a positive slope (0.83) and an adjusted $R^2$=0.996. In fact management preferred to delete from the analysis the number of clients instead of the number of regular clients, considering that the latter variable is more representative of the activity of the bank.

After completing the variable deletion test procedure, we have succeeded in reducing the number of service indicators from eight to four, because we have found the four deleted service indicators to be superfluous, containing no independent information of their own. We have been unable to reduce the number of resource indicators, since each of them is influential. A complete list of surviving influential indicators and deleted superfluous indicators appears in Table 3.

The frequency distribution of branch office overall financial performance efficiencies based on the four influential services appears in the second column of Table 2. There is no statistically significant difference between this distribution and that based on the complete set of eight services appearing in the first column. The simpler model generates slightly fewer efficient branch offices, as it must mathematically, but it generates the same range of branch office financial performance efficiency scores. The mean is also marginally lower, but both means imply that, on average, branch offices are capable of a 13% reduction in their expenses without a compensating reduction in their financial and customer base characteristics. Otherwise the two frequency distributions appear to be virtually identical. The similarity of the two frequency distributions is illustrated in Figure 1. Underlying Figure 1 is the fact that 304 branch offices have exactly the same overall financial performance efficiency in the two models, an additional 180 branches experience a less than 1% decrease in efficiency in the final model, and only seven branch offices experience an decrease in efficiency in excess of 5% in the final model. The fact that deletion of four revenue indicators affected the overall financial performance evaluation of 85% of branch offices by less than 1% attests to the superfluous nature of the four deleted indicators.

### *4.3 DEA and FDH Evaluations of Overall Financial Performance*

We are now prepared to conduct an evaluation of the overall financial performance of the branch offices. Although we base our evaluation on the reduced list of indicators containing eight influential indicators, we are assured by the statistical tests conducted in Section 4.2 that essentially the same evaluation would result from the complete list of indicators.

We are interested in extracting maximum information from the DEA and FDH financial performance evaluations, since they provide complementary insights. Since DEA is relatively demanding, its most useful information identifies high-performing branch offices. Since FDH is relatively generous, its most useful information identifies low-performing branch offices. In addition, FDH provides dominance information that complements both financial performance distributions.

The DEA results have already been discussed; they are summarized in the second column of Table 2 and illustrated in Figure 1. We conducted the FDH analysis with the complete model and with the reduced model. The results of the two models are even more similar than in the DEA case. In the complete model there are only 30 units with an efficiency score less than 1, while in the reduced model we found 40. Nevertheless the range of variation of the inefficiency scores was exactly the same for both models. Moreover, 29 of 30 inefficient offices from the complete model received exactly the same efficiency score in the reduced model. Consequently results of the variable deletion test, which was applied only in the DEA case, were validated by the FDH models.[14] FDH efficiency scores are not summarized by a frequency distribution in Table 2 because FDH assigns an efficiency score of unity to 93% (533 of 573) branch offices. The scores of the 40 radially inefficient branch offices are contained in the range [0.998, 0.713], with a mean of 0.902.

As we indicated in Section 3.1, the generosity of FDH encourages us to examine the bottom of the performance distribution. In Table 4 we list the bottom 25 branch offices, according to two criteria. In the first three columns we list the bottom 25 branch offices as revealed by their FDH efficiency scores, and we compare their FDH and DEA efficiency score ranks. In the next three columns we list the 25 most frequently dominated branch offices according to FDH, and we compare their FDH and DEA efficiency score ranks. Although FDH assigns consistently higher performance scores than DEA does, it is abundantly clear from Table 4 that the two techniques are in substantial agreement on the identity of the worst-performing branch offices. Nearly half (11 of 25) of the branch offices receiving the lowest FDH efficiency scores also receive the lowest DEA efficiency scores, and over a third (9 of 25) of the most frequently dominated branch offices according to FDH receive the lowest DEA efficiency scores.

In light of the concordance between the DEA and the FDH performance rankings, it is relatively easy to identify the 15 branch offices most in need of bank management attention. These branch offices have ID numbers 911, 102, 832, 840, 802, 272, 818, 110, 336, 310, 260, 320, 186, 188 and 338. Each is among the 25 most frequently dominated branch offices, and most of them are at the bottom of both efficiency score rankings.

## 5. Summary and Conclusions

In this paper we have evaluated the financial performance of the vast majority of the branch offices of a large European savings bank. Our evaluation has been based on a list of indicators currently used by the bank for the same general purpose. The indicators include four expense items, an inclusive revenue item, two size indicators, three customer base characteristics, and a pair of financial ratios. We have used a pair of complementary methodologies, DEA and FDH, to evaluate financial performance, and we have used a pair of complementary criteria, efficiency analysis and dominance analysis, to implement the evaluation.

Our first finding concerns the financial performance of branch offices. Our primary analytical technique, DEA, revealed a wide range of performance variation, with worst performance capable of a 45% reduction in resource consumption without any offsetting reduction in service provision. This range holds for the initial 12 variable model and for the final eight variable model. The implication of this finding is that efficiency improvement at the worst-performing branch offices can generate a substantial increase in profit for the bank.[15]

Our second finding is that the list of 12 indicators (which is smaller than the list used by the bank) is unnecessarily, and expensively, large. We have found the four expense indicators to be influential, and so we are unable to delete any of them without statistically significant loss of information to bank management. However we have also demonstrated that four of the eight service indicators are superfluous, and contain no independent information of their own concerning the financial performance of branch offices. The four superfluous service indicators can be deleted from the financial performance evaluation exercise with no statistically significant loss of information to bank management. Stated somewhat differently, when these four service indicators are deleted from the variable list, only 89 of 573 branch offices incurred more than a 1% decline in their performance rating, and only five branch offices incurred more than a 5% decline. Since the two performance rankings are statistically indistinguishable, the bank has the potential to conserve on monitoring and compliance costs by reducing the number of indicators on which it bases its performance evaluation, once again pointing to the feasibility of a streamlining of the bank's branch office evaluation procedures.

Perhaps the most useful information we can provide bank management is the identities of the worst performing branch offices in its network. Our third finding is that our primary analytical technique, DEA, and our secondary technique, FDH, as well as our two performance criteria, efficiency and dominance, identify essentially the same low-performing branch offices. This is reassuring, because it generates confidence in our findings, and it is also of considerable value to bank management, because it identifies problem branch offices in need of remedial action.

Our financial performance evaluation has been based on detailed branch office information provided to us by bank management. The variable list has benefited from frequent discussions with bank management. Nonetheless, potentially useful information has been unavailable to us. This information concerns the characteristics of the operating environment in which branch offices seek to minimize the expenses required to provide revenue-generating services to their customers. Information on operating environment characteristics, such as the population in the surrounding area of each branch, the age of each branch, the degree of competition in each branch's neighborhood, and so on, would prove useful in levelling the playing field prior to conducting the financial performance evaluation. Techniques for incorporating such characteristics into the analysis have been developed by Daraio and Simar (2003) and Simar and Wilson (2003).

**Table 1**
**Indicators Available for an Evaluation of the Financial Performance of 573 Branch Offices of the Savings Bank**

| ***Resources*** | ***Services*** |
|---|---|
| Personnel expense | Interest income |
| Other operating expense | Deposits |
| Deposit interest expense | Assets |
| Delinquencies | |
| | Number of customers |
| | Number of regular customers |
| | Number of high-income customers |
| | |
| | Return on Assets |
| | Profitability |

**Table 2**

**Distribution of Branch Office Financial Performance Efficiencies, by Percentile**

| Percentile | *Efficiency Scores* 12 Indicator Model (4 Resources, 8 Services) | 8 Indicator Model (4 Resources, 4 Services) |
|---|---|---|
| 10 | 1.000 | 1.000 |
| 20 | 1.000 | 1.000 |
| 30 | 0.982 | 0.973 |
| 40 | 0.933 | 0.922 |
| 50 | 0.883 | 0.877 |
| 60 | 0.846 | 0.841 |
| 70 | 0.809 | 0.804 |
| 80 | 0.759 | 0.752 |
| 90 | 0.715 | 0.713 |
| 100 | 0.546 | 0.546 |
| Number of Efficient Branch Offices (%) | 158 (27.6%) | 147 (25.7%) |
| Mean Efficiency Score | 0.873 | 0.868 |

**Table 3**

**Influential and Superfluous Financial Performance Indicators**

| *Influential Indicators* | *Superfluous Indicators* |
|---|---|
| Personnel expense | |
| Other operating expense | |
| Deposit interest expense | |
| Delinquencies | |
| | Interest income |
| Deposits | |
| Assets | |
| Number of regular customers | |
| | Number of customers |
| Number of high income customers | |
| | Return on assets |
| | Profitability |

**Table 4**

**The Worst Performing Branch Offices, by FDH and by DEA**

| *Ranked by FDH Efficiency Score* | | | *Ranked by FDH Dominance* | | |
|---|---|---|---|---|---|
| Branch Office ID# | FDH Rank | DEA Rank | Branch Office ID# | FDH Rank | DEA Rank |
| 102 | 573 | 573 | 911 | 572 | 563 |
| 911 | 572 | 563 | 102 | 573 | 573 |
| 832 | 571 | 553 | 832 | 571 | 553 |
| 840 | 570 | 561 | 840 | 570 | 561 |
| 818 | 569 | 570 | 802 | 563 | 571 |
| 260 | 568 | 544 | 272 | 551 | 518 |
| 924 | 567 | 529 | 818 | 569 | 570 |
| 944 | 566 | 485 | 110 | 533 | 542 |
| 333 | 565 | 527 | 336 | 552 | 540 |
| 186 | 564 | 566 | 310 | 540 | 536 |
| 802 | 563 | 571 | 260 | 568 | 544 |
| 789 | 562 | | 944 | 566 | 485 |
| 175 | 561 | 560 | 760 | 560 | |
| 760 | 560 | | 320 | 553 | 552 |
| 240 | 559 | 508 | 993 | 549 | 515 |
| 410 | 558 | 538 | 164 | 538 | |
| 460 | 557 | 550 | 206 | 531 | 567 |
| 400 | 556 | 488 | 186 | 564 | 566 |
| 174 | 555 | 524 | 188 | 554 | 568 |
| 188 | 554 | 568 | 768 | 547 | 492 |
| 320 | 553 | 552 | 338 | 546 | 559 |
| 926 | 552 | 510 | 781 | 545 | |
| 272 | 551 | 518 | 826 | 539 | 496 |
| 989 | 550 | | | | |
| 993 | 549 | 515 | | | |

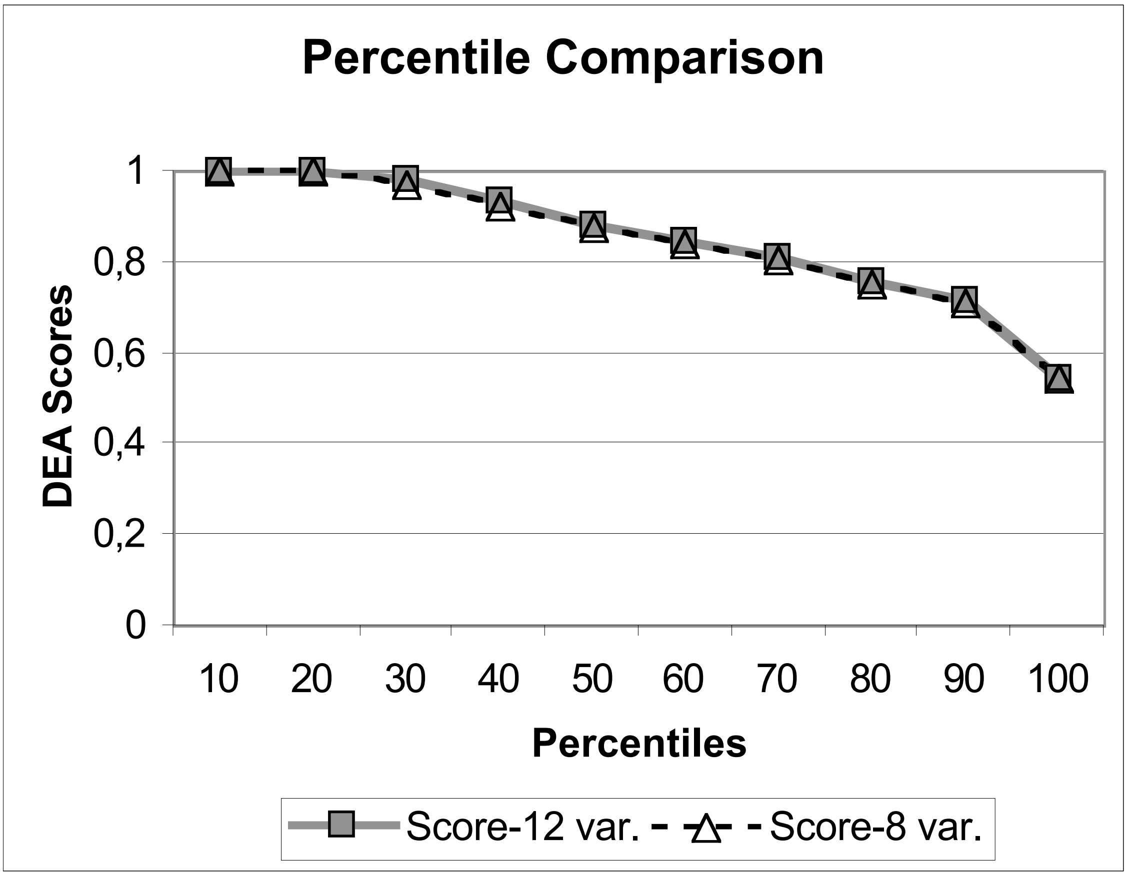


**Figure 1 - Frequency Distributions of Efficiency Scores in the Complete and Reduced Models**

## Footnotes

1. An identical formulation of FDH, called MED, a measure of efficiency dominance, was proposed at the same time by Bowlin *et al.* (1984).

2. Numerous studies have used DEA to examine bank branch operating performance, including Oral and Yolalan (1990), Vassiloglou and Giokas (1990), Giokas (1991), Drake and Howcroft (1994), Parkan (1994), Boufounou (1995), Haag and Jaska (1995), Sherman and Ladino (1995), Athanassopoulos *et al.* (1996), Nash and Sterna-Karwat (1996), Athanassopoulos (1997), Lovell and Pastor (1997), Schaffnit *et al.* (1997), Athanassopoulos (1998), Camanho and Dyson (1999), Soteriou and Zenios (1999a, 1999b), Xue and Harker (1999), Golany and Storbeck (1999), Kantor and Maital (1999), Soteriou *et al.* (1999), Athanassopoulos (2000), Athanassopoulos and Giokas (2000), Dekker and Post (2001), Hartman *et al.* (2001), and Portela *et al.* (2003). A handful of studies have used FDH for the same purpose, including Respaut (1989), Tulkens (1993), and Tulkens and Malnero (1996).

3. An excellent illustration of the use of alternative empirical methodologies for cross-validation purposes is provided by Charnes *et al.* (1988), who used DEA and goal programming to provide complementary analyses of the breakup of AT&T in the US.

4. The technical reason we choose a resource conserving orientation is that one of the services, profitability, attains negative values for 161 branch offices. This variable must be translated, so that all values are nonnegative. Lovell and Pastor (1995) have shown that a radial output-oriented linear programming model of performance evaluation is not invariant with respect to translation of services, but that a radial input-oriented linear programming model is invariant with respect to translation of services. An economic argument in support of a resource conserving orientation is that services are more likely to be exogenous to branch office management than resources.

5. The phrase “suggests that” means “is necessary but not sufficient for,” since optimal $\theta = 1$ is necessary and sufficient for *radial* efficiency, but is not sufficient for overall efficiency, since slacks may be present. In our empirical exercise we have found slacks to be neither large nor systematic.

6. Adding the constraint $\lambda_k \in \{0,1\}$, k = 1,…,573, converts the DEA linear programming problem to an FDH mixed integer programming problem. A simple minimax solution algorithm is described in Tulkens (1993).

7. Dominance analysis is an under-utilized performance evaluation technique, although it has been used by Fried *et al.* (1993, 1995), Lovell (1995) and Tulkens and Malnero (1996).

8. Kneip *et al.* (1998) show that the rates of convergence of the DEA and FDH estimators are given by $\theta^{DEA} - \theta = O_p(J^{-2/M+N+1})$ and $\theta^{FDH} - \theta = O_p(J^{-1/M+N})$, where J is the sample size and M and N are the number of outputs and inputs. Simar and Wilson (2001) propose several test statistics for superfluous variables, one of which corresponds to our statistic $\rho_j = \theta_j^r/\theta_j^t$, j=1,…,J. However rather than imposing a parametric distribution on this statistic, they employ bootstrapping techniques.

9. DEA allows producers freedom to choose the weights they attach to inputs and outputs in order to maximize their efficiency. This leads to a multiplicity of efficient producers and allows only a partial ranking of producers, and can be considered another curse of dimensionality. The curse is even worse with FDH. An attempt to create a complete ranking by using a super-efficiency DEA model to break ties at the top is provided by Xue and Harker (2002).

10. The p-value associated with T=3 is 0.000000453, and consequently the null hypothesis cannot be rejected. The two efficiency distributions are statistically indistinguishable and the two financial ratios can be deleted.

11. The p-value associated with T=190 is 1 (with an error less than 0.00000001. Hence the null hypothesis is rejected.

12. The test statistic associated with the deletion of each of the four service indicators from the original 12 indicator model are: T=187 for personnel expense, T=104 for other operating expense, T=407 for deposit interest expense, and T=153 for delinquencies. The p-value associated with T=104 is 1 (with an error less than 0.00000001) and therefore all the remaining p-values are also 1 (with an error less than 0.00000001). In each of the four cases the null hypothesis is rejected. Since the deletion of an indicator after others have already been

deleted gives a larger value of T (see Pastor *et al.* (1997)), we are sure that, after deleting the two financial ratios, we are unable to delete any single resource.

13. The test statistic when comparing the complete model with the reduced model with only eight indicators is T=5, with a corresponding p-value of 0.00000299. Hence the null hypothesis cannot be rejected.

14. The variable deletion test can also be applied directly to an FDH model, as explained in Pastor *et al*. (2002).

15. The DEA results indicate that elimination of branch office inefficiency *within the bottom decile only* would result in a cost saving to the bank of an amount which exceeds the average branch office expense by a factor of 23.

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