Problems in Bank Branch Inefficiency: Management, Scale and Location

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ABSTRACT

This study evaluates the operating performance of a savings bank's branches using data envelopment analysis. In addition to the identification of the inefficient branches, the study breaks down the constituent components of operating efficiency, investigates scale properties, estimates the potential resource savings and output increments as well as examines the inefficiency problems in depth for each less-productive branch. The main results indicate that the operational inefficiencies are generally contributed by a greater degree of wasteful overuse of resources and to a smaller degree by operating at an inapropriate scale. Moreover, the savings bank is estimated to be able to save annual operating expenses of between USD 3.6 and 3.7 million, and to attract added deposits of between USD 63.9 and 199.9 million as well as to provide additional loans of between USD 9.3 and 15.3 million. Finally, the less efficient branches are identified as having the following disadvantages: weaker managers, diseconomy of scale, and unfavorable location. The findings of the study are consistent with the conceptions of management and provide a verification of their perceptions.

Key words: bank management, performance evaluation, efficiency, economy of scale, intermediation approach, production approach, data envelopment analysis.

1. INTRODUCTION

During the last two decades, the banking industry has experienced radical transformation not only in major industrial countries, but also in several developing countries. These changes are characterized by deregulation, innovation and globalization. Intensified competition, squeezed margins and bank failures are the salient feature of the picture. As a consequence, operating performance becomes a crucial competitive factor to master the challenges following from structural changes brought by internationalization, financial innovations and changes in customer demands. If banks wish to hold their own position amongst the numerous domestic and international contenders, they have to continuously improve their efficiency and be able to achieve substantial cost savings without sacrificing quality of service. Thus, performance measurement and its strategic implications are increasingly gaining greater emphasis in the banking sector. Management seem to have some kind of perception of the performance of each branch. However, it is hard to identify these subjective conceptions. The purpose of this study is mainly focused on the operational aspects and tries to give some objective observations to management.

Traditionally, the performance of service organizations like banks has been frequently measured by using financial ratios such as deposits to loans, return on assets, ratio of operating costs to total assets, etc. However, the most critical limitation of the financial ratios is that they fail to consider the multiple

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input-output characteristics of the banks, which should relate a set of resources utilized (inputs) to a set of services provided (outputs) while keeping the mixtures of resources and services in perspective. Since each of these ratios only gives a partial and incomplete picture of organizational operations, a bank's performance may exhibit considerable variation depending on the different indicator chosen. Furthermore, the financial ratios are generally used to extract information about financial performance, but they do not investigate how well a bank succeeds in transforming various resources into specific services. In recent studies, much attention has been directed to either parametric or nonparametric methods, since they are able to provide comprehensive insights beyond those available from financial ratios for evaluating and improving bank operations.

The parametric method, based on econometric techniques, is an extension of the classical econometric analysis of minimum cost, maximum profit as well as production functions and is aimed at improving OLS regression estimation; while the nonparametric method relies on mathematical programming techniques to envelop a data set in a multidimensional input-output space. Each of the methods has its defects and merits relative to the other. Up to now, the literature has not yet come to an agreement about the preferred method for determining the frontier of the production function against which operational performance is measured. In this paper, the nonparametric data envelopment analysis is applied to evaluate performance for a network of bank branches. Unlike the parametric method, it allows us to determine our frontiers without having to impose unwarranted structure on our models by prespecifying functional forms or distributional assumptions about error terms. According to Berger (1993), the distributional assumptions usually imposed in the literature were not very consistent with the banking data using parametric methods.

A number of DEA-based studies by, for instance, Sherman and Gold (1985), Parkan (1987), Giokas (1990), Oral and Yolalan (1990), Vassiloglou and Giokas (1990), Oral, Kettani and Yolalan (1992), Al-Faraj, Alidi and Bu-Bshait (1993), Boufounou (1995), Sherman and Ladino (1995), Schaffnit, Rosen and Paradi (1997), Golany and Storbeck (1999), and Zenios, Zenios, Agathocleous and Soteriou (1999) have been conducted for the major purpose of evaluating the performance at the bank branch level. Our paper follows the same method but attempts to obtain more informative and robust results by defining branch activities in two different ways, intermediation and production approaches. Moreover, not only do we place emphasis on input saving measures as the previous work, we also focus our attention on output expansion measures. Additionally, we deal with the issue concerning returns to scale within the banking production process, which has been rarely addressed in the aforementioned studies.

The rest of the paper unfolds as follows. The next section proposes methodology for assessing performance of bank branches based on the concepts and principles of nonparametric methods. Then we discuss how to identify inputs and outputs for the banking sector, along with a description of the data underlying our analysis. Finally, we report and discuss the empirical results and conclude the paper.

2. THE METHODOLOGY

2.1 Evaluation of Branch Performance

Traditionally, managers have to rely more on their experience and instincts to identify inefficient branches. However, to compare the branch performance in all aspects is difficult. Data envelopment analysis (DEA) is a useful managerial implement based on mathematical programming for performance evaluation. Since the original model of DEA first developed by Charnes, Cooper and Rhodes (1978), the literature has grown speedily. So far, there have been many alternative models proposed by various researchers for their varied applications. In general, these models differ in their orientations (input or output), returns to scale (constant, variable, non-increasing, or non-decreasing), disposability (strong or weak), types of measures (radial, non-radial or hyperbolic), and so forth. In this section, we describe the two basic DEA models, namely, the CCR model (Charnes et al., 1978) as well as the BCC model (Banker, Charnes, & Cooper, 1984) from their input and output orientations.

Consider that there are *k* bank branches to be evaluated. Each consumes varying amounts of *n* inputs to produce *m* outputs. For each branch *j* (*j*=1, 2, …, *k*), *X* indicates the ($n\times k$) matrix of inputs and *Y* denotes the ($m\times k$) matrix of outputs. We assume further that $X \in R^{+}$, $Y \in R^{+}$ and each branch has at least one positive input and one positive output.

The input-oriented CCR model for efficiency measurement can be formulated as follows:

$$
\begin{aligned}
\max_{u,w}\ & \gamma_o = U^T Y_o / W^T X_o \\
\text{s.t.}\ & U^T Y / W^T X \le 1; \qquad (1) \\
& U^T \ge \varepsilon e^T; \\
& W^T \ge \varepsilon e^T.
\end{aligned}
$$

where subscript ($_o$) denotes the branch being evaluated from the observed data; γ_o is the efficiency rating of the branch being evaluated; $U=(u_1,u_2,\cdots,u_m)^T$ and $W=(w_1,w_2,\cdots,w_n)^T$ are the vectors of input and output weights; ε is a non-Archimedean infinitesimal constant and *e* is a vector of ones in each of its components.

Performing a DEA analysis is to seek the solution of *k* linear programming problems for Program (1), one for each branch *j*. A branch is designated relatively efficient if the optimal value γ_o^* is equal to unity, while relatively inefficient if γ_o^* is less than unity. DEA first identifies the relatively best practices to define the efficient frontier and then measures the extent of inefficiency for the other branches relative to this frontier. Nonetheless, the above problem cannot be always solved as stated because of the difficulties associated with nonlinear fractional mathematical programming. Using a mathematical transformation, it can be replaced with the ordinary linear programming model equivalents below (Charnes & Cooper, 1962):

$$\max_{\mu,\,\omega} \quad \tau_o = \mu^T Y_o$$
$$\text{s.t.} \quad \mu^T Y - \omega^T X \le 0; \qquad (2)$$
$$\omega^T X_o = 1;$$
$$\mu^T \ge \varepsilon e^T;$$
$$\omega^T \ge \varepsilon e^T.$$

The dual problem to (2) is displayed below:

$$\min_{\theta_o,\lambda,S^+,S^-} \quad \nu_o = \theta_o - \varepsilon\,(e^T S^+ + e^T S^-)$$
$$\text{s.t.} \quad Y\lambda - S^+ = Y_o; \qquad (3)$$
$$X\lambda + S^- = \theta_o X_o;$$
$$\lambda, S^+, S^- \ge 0$$

where $\lambda = (\lambda_1, \lambda_2, \cdots, \lambda_k)^T$ is the vector of intensity weights defining the linear combination of best-practice units to be compared with the branch being evaluated; S^+ and S^- represent nonnegative slack variables, and $S^+ = (s_1^+, s_2^+, \cdots, s_m^+)^T$ and $S^- = (s_1^-, s_2^-, \cdots, s_n^-)^T$.

Program (1) provides the clearest interpretations of DEA, whereas the *multiplier problem* in (2) or the *envelopment problem* in (3) is generally employed for computational purpose. The duality theorem of linear programming warrants that $\nu_o^* = \tau_o^*$, where the superscript (*) denotes an optimum value.

The optimum value λ^* in Problem (3) can be used to locate and understand the nature of existing inefficiencies for the evaluated branch, if there is any. Those branches for which $\lambda^*>0$ constitutes the efficiency reference set with which the evaluated branch compares to calculate its amounts of excess inputs and deficient outputs. The composite input quantities X_o^* and output quantities Y_o^* of the hypothetical efficient branch are expressed in Equations (4) and (5) below, respectively:

$$X_o^* = X\lambda^*; \qquad (4)$$

$$Y_o^* = Y\lambda^*. \qquad (5)$$

By calculating the differences between the actual and the composite efficient levels, the inefficiency amounts for each input and output of the base branch can be derived.

The programs in (1) to (3) using constant returns-to-scale reference technology are referred to as the CCR models. By introducing restrictions on the sums of intensity weights, DEA can also accommodate variable returns-to-scale technology for calculating pure technical efficiency measures. Scale efficiency is thereby obtainable by computing the ratio of technical efficiency to pure technical efficiency. A BCC model adds the following constraint in (3):

$$e^T\lambda = 1. \qquad (6)$$

The optimum value of $e^T\lambda^*$ can be used to determine the nature of the *scale properties*. If $e^T\lambda^* > 1$, this implies that we have *increasing returns to scale* (IRS) in the region of production technology. On the contrary, $e^T\lambda^* < 1$ indicates *decreasing returns to scale* (DRS). The *constant returns to scale* (CRS) occurs when $e^T\lambda^* = 1$.

Similarly, one can also focus upon the output side and formulate the output-oriented CCR model as follows:

$$\begin{aligned} \min_{u,w} \quad & \eta_o = W^T X_o \ / \ U^T Y_o \\ \text{s.t.} \quad & W^T X \ / U^T Y \ \geq 1; \\ & U^T \geq \ \varepsilon \, e^T; \\ & W^T \ \geq \ \varepsilon \, e^T. \end{aligned} \tag{7}$$

In a similar manner, the nonlinear fractional program (7) should be replaced with the ordinary linear programming model equivalents for the computational purpose and thus derive the multiplier problem in (8) and the envelopment problem in (9):

$$\begin{aligned} \min_{\mu,\,\omega} \quad & \psi_o = \omega^T X_o \\ \text{s.t.} \quad & \mu^T Y - \omega^T X \leq 0; \\ & \mu^T Y_o = 1; \\ & \mu^T \geq \ \varepsilon \, e^T; \\ & \omega^T \geq \ \varepsilon \, e^T. \end{aligned} \tag{8}$$

$$\begin{aligned} \max_{\phi_o,\lambda,S^+,S^-} \quad & \rho_o = \phi_o + \varepsilon \ (e^T S^+ + e^T S^-) \\ \text{s.t.} \quad & Y\lambda - S^+ = \phi_o Y_o; \\ & X\lambda + S^- = X_o; \\ & \lambda, S^+, S^- \geq 0. \end{aligned} \tag{9}$$

The expression of output-oriented models is analogous to that of input-oriented models and the definitions of the variables of the former are also similar to those of the latter. We leave out the discussions about these models, since most explanations given earlier can be applied here.

2.2 Measures of Inputs and Outputs

Since operations represents all relevant branch activities which transform a set of resources into a set of services, a definition of banking activities is essential prior to operating performance measurement. That is, we should first make sure what a bank actually produces, what resources a bank consumes and how to measure those properly. Although much work has debated this issue, to date little agreement on the theory of banking production leaves this kind of definition still unsettled. Broadly speaking, there exist five approaches to the input-output specification in banking (Berger & Humphrey, 1992; Colwell & Davis, 1992).

They are the *intermediation approach* (IA), *production approach* (PA), *asset approach* (AA), *valued-added approach* (VAA) and *user cost approach* (UCA) –– each is considered from a different view and has its advantages and disadvantages.

The IA considers a bank's production process to be financial intermediation behavior related to borrowing funds from depositors and subsequently lending them to others. According to this approach, inputs include various costs of funds purchased, for instance, labor, capital, operating costs and interest expenses, while outputs are measured by monetary values of varied earning assets such as loans and investments. Deposits may be considered as either inputs or outputs. It should be noted that the total costs must include interest expenses in addition to operating costs, because the IA places emphasis on the banks' role as intermediaries of financial services. The IA has the advantage in that the data are easily available from financial statements. However, it is a stock concept. Production should be a flow concept, expressed as some amounts per unit of time, but deposits, loans and investments represent given amounts at a certain time point. In practice, how many loans and investments a bank has made depends not only on the amount outstanding when the balance sheet is calculated but also on the extensions, repayments and the amount outstanding reported in the previous balance sheet (Mackara, 1975). Moreover, the IA cannot avoid the effect of inflationary bias.

The PA regards banks as producers who produce different categories of deposit and loan services. Under this approach, only physical resources, like labor, capital and materials, should be included in input items. In contrast to the IA, interest expenses, not consuming real resources, have to be excluded from total costs. Moreover, the PA is radically different from the IA in that it avoids as much as possible using value amounts in defining bank products. Outputs are thus measured by either the number of accounts handled or the number of transactions processed carried out on each type of product. The PA can tackle some problems of the IA. For example, it removes the inflation bias, since numbers without a price dimension are used rather than monetary values. Again, by this approach output is expressed as a flow concept (the number of accounts or transactions per unit of time), so that the stock-flow problem is circumvented. Nevertheless, the PA is not without flaws. It omits many important items of banking services and gives the same treatment to accounts of different sizes. Another shortcoming is that the use of a number of accounts presents a problem in that equal costs per account across various types of accounts are assumed. In fact, demand deposit accounts, for example, may be more active and thus more costly to maintain than time deposit accounts; while installment loan accounts may be more costly to maintain than the industrial loan accounts (Kolari & Zardkoohi, 1987).

The rest of the three approaches are deemed as variants of the IA and face the same difficulties as the IA. The VAA considers that all items on both sides of the balance sheet may be identified as inputs or outputs entirely dependent upon their share of the added value. If a balance sheet item generates a considerable share of a bank's added value, that is, this item absorbs a meaningful percentage of the capital and labor costs, then it is an output. Otherwise, it must be an input or an unimportant output (Berger & Humphrey, 1992). The VAA can capture the dual role of deposits as both inputs and outputs. However, we need more accurate accounting information to calculate the added value for balance sheet items, but such data are not always available. The AA treats bank liabilities as inputs since they provide the "raw material" of loanable funds while most bank assets are treated as outputs since they ultimately utilize the funds generating the bulk of the direct revenue earned by banks. According to the AA, banks are considered only as financial intermediaries between liability holders and those who receive bank funds. Only intermediation services, which transform balance-sheet liabilities into assets, and receive interest to cover the time value of the funds, are considered as outputs (Berger & Humphrey, 1992). The UCA views banks as producers of financial services, who transform the physical resources into financial products. A product is a financial output when its economic return is positive and a financial input when its economic return is negative (Fixler & Zieschang, 1992). In other words, whether a financial product is an input or an output all depends on its net contribution to the bank revenue. Since there have been many debates about the status of financial products, UCA seems valuable to identify inputs and outputs objectively. Unfortunately, this approach is difficult to carry out, because some problems would arise when measuring financial revenues and opportunity costs.

The five approaches stress different aspects of banking operations. Neither of them is perfect, because none of them can capture the full role of a bank and none of them can consider the problem of product quality. Until now, researchers are still divided over the issue of which approach is most appropriate to the measures of bank outputs and inputs. The choice between alternative approaches usually depends upon the concept regarding the role of banks or the specific issue under consideration and especially upon the availability of empirical data. Due to the available database we follow both the IA and the PA, which are the most prevalent in the literature. In general, the limitations of the former are mostly the strengths of the latter and the converse is also true. To some extent, these two approaches would complement each other. In order to determine whether the empirical results are affected by the choice of output specification, in this paper we utilize both approaches to measure activity levels of banking production and carry out parallel analyses.

3. THE DATA

For the purposes of assessing operating efficiency, a sample of 12 branches taken from a German local savings bank during the years 2000 to 2004 is employed in this study. In Germany, the savings bank sector is generally incorporated under public law and consists of three tiers—it has a large number of local savings banks and a system of state savings banks, headed by a central savings bank, the Deutsche Girozentale. They altogether only represent 18% of domestic banks, but they have the largest market share in the industry, around 36% of total domestic banking assets. The local savings bank under investigation, located in the suburbs of Berlin, is chosen because it has the data concerning our study that can be divulged to us.

We identify labor, capital and materials as our three *inputs* that reflect the resources required to produce the outputs.

The input of labor is measured by full time equivalent employees per branch and contains all the personnel working for the branch, including tellers, accounting officers and branch management. Besides the full-time staff, part-time employees are also included in this item by calculating the ratio of their work hours. The annual rent paid for each branch is used as a proxy of the input of capital. In the previous studies, either utilized floor space or book value of premises and fixed assets is considered as a measure of capital. However, we have no access to such data, so the closest available substitute is the annual rent. The input referred to as materials covers all the operating costs excluding both salaries and rent, such as expenses on EDP, telephone, electricity, postage, stationery and other supplies. This variable is measured in monetary terms due to difficulty of grouping all widely different units of measurement together.

On the output side, two alternative categories of data are used. The first one measures deposits and loans by their number of accounts and the second one by their monetary value. For each category of data, the *outputs* include the following two types of banking activities, reflecting the basic functions of savings banks. The first output is deposits, which are comprised of three produced deposits: sight deposits which are funds payable on demand at any time the depositors elect or within one month after deposits; time deposits which are defined as the funds with a maturity of one month and over; and savings deposits which have no specified maturity. The output of loans includes short-term and long-term loans to credit institutions as well as to customers.

Table 1. *Summary statistics of the bank branch data*

	Inputs			Outputs - IA		Outputs - PA	
	Labor	Capital	Materials	Deposits	Loans	Deposits	Loans
Total	64.30	2,060.00	5,095.00	674,539.00	91,590.00	99,367.00	3,603.00
Mean	5.36	171.67	424.58	56,211.58	7,632.50	8,280.58	300.25
S.D.	1.81	199.63	306.26	39,021.89	4,046.19	3,990.44	130.24
Max.	7.30	494.00	914.00	130,188.00	15,565.00	12,745.00	476.00
Min.	2.00	13.00	84.00	8,896.00	1,367.00	1,042.00	129.00

Note. The output variables under the production approach are measured in number of accounts. All figures but labor are measured in thousand USD.

All values of our input and output variables are defined as an annual average value during the study period. Table 1 reports the total, arithmetic mean, standard deviation, maximum and minimum of each input and output variable described earlier. The statistics reveal a significant feature of our data. That is, the branches used in the study tend to be very small in size. On the other hand, we do not include any inputs that reflect market conditions, since all the branches in the data are situated in a small city of roughly 150 square kilometers. Accordingly, it seems justifiable to assume that these branches are operating in a reasonably similar market.

Since a strong correlation between input and output variables should be suggested in principle, this study further carries out a Pearson correlation analysis.

The results shown in Table 2 demonstrate a highly significant positive correlation between both input and output variables by the conventional standard of statistical significance. The Pearson correlation coefficients are between 0.628 and 0.965, so the input and output variables chosen are reasonable for the empirical models.

Table 2. *The Correlation between input and output variables*

	Deposit - IA	Loan - IA	Deposit - PA	Loan - PA
Labor	0.8983	0.814	0.8035	0.9123
	(0.0000) ***	(0.0013)**	(0.0016)**	(0.0000) ***
Capital	0.8662	0.6282	0.8169	0.8733
	(0.0003) ***	(0.0475)*	(0.0012)**	(0.0002) ***
Materials	0.9441	0.7784	0.9511	0.9650
	(0.0000) ***	(0.0358)*	(0.0000) ***	(0.0000) ***

Note. P-values are in parentheses; * indicates 5% significance level; ** indicates 1% significance level; *** indicates 0.1% significance level.

4. RESULTS AND DISCUSSIONS

Our empirical results are derived by analyzing a cross-sectional sample of 12 savings bank branches, in terms of their ability in utilizing labor, capital and materials to produce deposits and loans within the framework. The efficiency results based on both the IA and the PA for each branch are summarized in Table 3, where the first column denotes the branch code, TE is the index of technical (or operating) efficiency derived under the assumption of CRS technology, PTE indicates the index of pure technical efficiency derived under the assumption of VRS technology, SE represents the index of scale efficiency calculated as the ratio of TE to PTE, and RTS denotes the nature of the returns to scale. Note that the approach establishes a benchmark efficiency rating of *unity* that no individual branches' rating can exceed: If the value of the efficiency index is equal to unity, the branch is a best practice and is therefore identified as a relatively efficient one. By contrast, if the value is smaller than unity, the branch is less efficient compared with its *efficiency reference set*, a small subset of best practices identified by the approach most similar to the branch under assessment in the mix of services and resources. The bottom of the table provides some summary statistics in the form of mean, standard deviation and minimum value of the above indices.

The results from Table 3 suggest that 8 branches (two thirds) in the sample exhibit technical inefficiency with an efficiency rating of less than 1.0 under the IA. The technical inefficiency suggests the extent to which efficiency is lacking in comparison to the efficiency reference set. For example, at one extreme B_2 has an efficiency rating of only 0.514 based on the IA. This can broadly be interpreted as saying that B_2 should have been able to support its activity levels with only 51.4% of its resources. B_4 is less efficient with a rating of 0.863 based on the PA, indicating that it is using about 13.7% excess resources. The analysis also shows that branches such as B_5, B_9 and B_{10} are the best practices, indicated by the rating of 1.0 based on both approaches. Furthermore, except B_{12} under the IA, Table 3 reveals that all the branches in the sample enjoy a relatively high level of scale efficiency. On average, the TE, PTE and SE are 81.4%, 87.1% and 93.8%, respectively, under the IA, as opposed to 85.0%, 86.1% and 98.6%, respectively, under the PA.

Table 3. *The various efficiency indices with a statistical summary*

Branch code	Intermediation approach				Production approach			
	TE	PTE	SE	RTS	TE	PTE	SE	RTS
B_1	0.7749	0.7943	0.9756	IRS	0.5768	0.5878	0.9811	DRS
B_2	0.5140	0.5280	0.9734	IRS	0.6361	0.6492	0.9798	IRS
B_3	0.7769	0.7971	0.9747	DRS	0.6100	0.6220	0.9806	DRS
B_4	0.8227	0.8575	0.9594	IRS	0.8631	0.8652	0.9976	IRS
B_5	1.0000	1.0000	1.0000	CRS	1.0000	1.0000	1.0000	CRS
B_6	0.9030	0.9590	0.9416	IRS	0.8568	0.9049	0.9468	IRS
B_7	1.0000	1.0000	1.0000	CRS	0.9307	0.9311	0.9996	IRS
B_8	0.6499	0.7296	0.8907	IRS	0.8111	0.8574	0.9459	IRS
B_9	1.0000	1.0000	1.0000	CRS	1.0000	1.0000	1.0000	CRS
B_{10}	1.0000	1.0000	1.0000	CRS	1.0000	1.0000	1.0000	CRS
B_{11}	0.7742	0.7898	0.9802	IRS	0.9106	0.9124	0.9980	IRS
B_{12}	0.5540	1.0000	0.5540	IRS	0.7039	1.0000	0.7039	CRS
Mean	0.8141	0.8713	0.9375		0.8249	0.8609	0.9611	
S.D.	0.1746	0.1498	0.1248		0.1570	0.1547	0.0834	
Min.	0.5140	0.5280	0.5540		0.5768	0.5878	0.7039	

Note. TE, PTE and SE refer to technical efficiency, pure technical efficiency and scale efficiency, respectively. RTS, IRS DRS and CRS refer to returns to scale, increasing returns to scale, decreasing returns to scale and constant returns to scale, respectively.

We have already established that operating efficiency can be separated into its constituent components, PTE and SE. This enables us to identify the main source of operational inefficiency as being ascribable to pure technical effect, scale effect or even a combination of the two. Pure technical inefficiency arises from idleness or wastefulness of resources due to differences in managerial abilities to control costs and maximize revenues, while scale inefficiency occurs when a scale chosen for production is not optimal, i.e., the returns to scale are nonconstant, so that average costs are not minimized and can be lowered by increasing or reducing the scale of operations. Clearly, from Table 3, in the majority of cases operating inefficiency is caused by a greater degree of pure technical inefficiency and a smaller degree of scale inefficiency.

Finally, Table 3 also provides the information about scale property for each branch. We find that around 75.0% to 87.5% of the inefficient branches are operating at IRS. The issue is important because the answer helps to confirm whether the branches operate efficiently at large scale or small scale. The property of production process whereby a proportional increase in every input yields a more than proportional increase in output is said to exhibit IRS; while yields of less than proportional increase in output is said to exhibit DRS. The intermediate case, where a proportional increase in every input yields an equal proportional increase in output is said to exhibit CRS.

The differences observed in Table 3 between efficiency measures of the IA and PA can be further examined. Table 4 explores the relationship between the two types of efficiency measures by using a variety of correlation analyses. The Pearson product-moment correlation coefficients are calculated based on the original values of observations; whilst the coefficients of Spearman's rank correlation, Kendall's Tau-b correlation and Hoeffding's dependence are based on the rank values. The results show that except in one case, the relationships between the two types of efficiency measures are detected to be positive. Nevertheless, after a test of hypotheses, these relationships exist statistically only for pure technical efficiency and scale efficiency at the 5% significance level.

Table 4. *The correlation between alternative output measures*

Efficiency indices	Correlation coefficients			
	Pearson	Spearman	Kendall	Hoeffding
Technical efficiency	0.4836	0.5127	0.4167	0.0360
	(0.1112)	(0.0883)	(0.0741)	(0.1463)
Pure technical efficiency	0.7538	0.8193	0.6901	0.2502
	(0.0046)*	(0.0011)*	(0.0036)*	(0.0017)*
Scale efficiency	-0.0008	0.5815	0.5833	0.2532
	(0.9981)	(0.0473)*	(0.0124)*	(0.0016)*

Note. P-values are in parentheses; * indicates 5% significance level.

Tables 5 and 6 estimate the potential improvements for each inefficient bank branch such as B_1, B_2, B_3, B_4, etc., based on the IA and the PA, respectively. The potential improvements consist of the following two parts: the first is the amount and the percentages of savings by a specific resource type; and the second is the amount and the percentages of service volume increments by a specific output type. These improvements are practically achievable on the assumption that the less efficient branches would improve their performance to the level which is achieved by their efficiency reference set. Specifically, for example, from Table 5, B_4 should be able to provide its current service level with 2.0 fewer employees, USD 94.3 thousand less in rental costs and USD 247.1 thousand less in materials; simultaneously, it could attract USD 10,067.0 thousand more in deposits and USD 2,518.6 thousand more loans without utilizing additional resources. Similarly, from Table 6, B_2 should be able to provide its current service level with 1.8 fewer employees, USD 431.0 thousand less in rental costs and USD 476.0 thousand in materials; at the same time, it could handle around 3,069.5 additional deposits and 105.0 added loans without utilizing additional resources. In the same way, for either of the other less-productive branches in Tables 5 and 6, we can explore the nature of inefficiencies and identify the particular sources of operational problems where effort should be focused to achieve improvements in performance. In total, as Table 6 exhibits, this savings bank with 12 branches should be able to reduce 6.2 employees, USD 1,553.5 thousand in rental cost and USD 1,797.1 thousand in materials, as well as increase 9,406.7 deposits and 364.7 loans. Such information can help management take the most feasible measures to remedy inefficient areas in order to achieve more efficient allocation in resources and to predict the potential business expansion for strategic planning.

The two alternative ways of output measures obtain somewhat different results in estimating potential improvements. As to the input side, for instance, B_1 should be able to maintain its current service level with reducing labor by 0.3 unit, rent by USD 374.5 thousand and materials by USD 232.8 thousand, respectively, under the IA, as opposed to 1.0 unit, USD 429.2 thousand and USD 494.9 thousand, under the PA. In total, for this savings bank, the percentages of total input savings account for 15.7% with respect to the total number of employees, 68.0% with respect to the total rental costs, and 31.5% with respect to the total costs of materials using the IA. Using the PA, the corresponding ratios are 9.6%, 75.4% and 35.3%, respectively. On the other hand, without increasing the use of resources, this bank should be able to expand 29.6% in deposits and 16.7% in loans under the IA, versus 9.5% and 10.1%, respectively, under the PA.

Table 5. *Potential improvements based on intermediation approach*

Inefficient Branches	Potential input savings			Potential output increments	
	Labor	Capital	Materials	Deposits	Loans
B_1	0.26	374.49	232.77	62,987.90	596.14
	(3.53)	(75.81)	(25.47)	(48.38)	(6.10)
B_2	2.24	421.79	481.41	33,696.03	2,812.96
	(35.63)	(85.38)	(53.91)	(42.84)	(50.03)
B_3	0.37	379.70	251.50	61,909.65	2,203.21
	(5.51)	(76.86)	(27.85)	(49.72)	(18.57)
B_4	2.02	94.33	247.09	10,067.02	2,518.64
	(33.60)	(73.70)	(56.29)	(17.84)	(42.70)
B_6	0.32	3.03	63.26	2,965.14	490.75
	(7.05)	(7.05)	(23.34)	(7.58)	(7.58)
B_8	1.64	12.65	93.92	14,205.92	4,573.91
	(34.18)	(34.18)	(38.97)	(51.93)	(207.53)
B_{11}	2.18	108.73	198.26	6,932.56	978.08
	(36.28)	(66.71)	(51.76)	(14.73)	(9.49)
B_{12}	1.03	6.83	37.45	7,157.09	1,110.51
	(51.68)	(45.56)	(44.58)	(80.45)	(81.24)
Total	10.07	1,401.56	1,605.67	199,921.30	15,284.20
	(15.66)	(68.04)	(31.51)	(29.64)	(16.69)

Note. Figures in parenthesis indicate the % of excess inputs or deficient outputs of a branch compared with its efficient reference set. All variables but labor are measured in thousand USD.

Based on Tables 5 and 6, Table 7 summarizes the results of the total potential improvement amounts from the two alternative output measures by converting all physical quantities such as numbers of employees and numbers of accounts into personnel expenses and the monetary values of accounts, respectively. The results show that the savings bank with a total business volume of USD 835.66 million should be capable of saving operating expenses of USD 3.6 million (32.9%), attract added deposits of USD 199.9 million (29.6%) and provide additional loans of USD 15.3 million (16.7%) under the IA, in comparison with USD 3.7 million in operating expenses (34.0%), USD 63.9 million in deposits (9.5%) and USD 9.3 million in loans (10.1%) under the PA. The potential improvements in operating expenses, deposits and loans are equivalent to 0.4%, 23.9% and 1.8% of the business volume under the IA versus 0.4%, 7.6% and 1.1%, respectively, under the PA.

as being most inefficient B_2 was closed in 2005 due to weak managers and location problems. The location of this branch was in the suburbs and noticeably in the proximity of the branch B_1, which had better public transportation. Furthermore, the inefficiency was thought to arise from the supervision of newly appointed managers. Basically, managers with less experience were assigned to small or suburban branches of this savings bank. The analyses of the study were highly consistent with management's perceptions. The branch B_{12} was the smallest in scale and failed to achieve an economy of scale. Furthermore, it was situated in a remote town where the population density in the neighborhood was very low and the population had been trending down. Four identified less efficient branches, B_1, B_3, B_8 and B_{11}, were believed to be run by weaker managers. The four were relatively new branches and were supposed to far from well-known to customers. Relatively, the inefficiencies of the other two branches, B_4 and B_6, seem to be trivial. The identified three best practices, B_5, B_9, and B_{10}, were accordant with the knowledge of management. Management found that the results of the study helped to understand the in-depth operating aspects, which were not possible to obtain from the traditional profitability measures.

Table 6. *Potential improvements based on production approach*

Inefficient branches	Potential input savings			Potential output increments	
	Labor	Capital	Materials	Deposits	Loans
B_1	0.96	429.23	494.89	1,860.13	53.32
	(13.11)	(86.89)	(54.15)	(14.59)	(11.59)
B_2	1.84	431.02	475.95	3,069.51	104.97
	(29.24)	(87.25)	(53.30)	(25.10)	(22.62)
B_3	1.45	430.65	478.21	2,460.36	83.77
	(21.36)	(87.18)	(52.96)	(20.16)	(17.60)
B_4	0.21	83.41	141.18	26.07	11.82
	(3.43)	(65.17)	(32.16)	(0.30)	(3.55)
B_6	0.56	9.64	72.77	631.65	28.36
	(12.10)	(22.42)	(26.85)	(9.20)	(13.77)
B_7	0.33	44.13	15.83	101.38	16.70
	(4.96)	(45.97)	(4.96)	(0.98)	(5.22)
B_8	0.81	6.22	55.11	1,055.52	64.87
	(16.81)	(16.81)	(22.87)	(15.84)	(40.55)
B_{11}	0.01	119.22	63.19	202.04	0.92
	(0.25)	(73.14)	(16.50)	(2.53)	(0.25)
Total	6.16	1,553.52	1,797.12	9,406.65	364.74
	(9.58)	(75.41)	(35.27)	(9.47)	(10.12)

Note. Figures in parenthesis indicate the % of excess inputs or deficient outputs of a branch compared with its efficient reference set. All variables but rent and materials are measured in numbers. Rent and materials are measured in thousand USD.

Table 7. *Estimates of potential improvement amounts*

	Intermediation approach			Production approach		
	Thou. USD	% of total	% of bus. vol.	Thou. USD	% of total	% of bus. vol.
Operating expenses	3,599.46	32.91	0.43	3,713.14	33.95	0.44
Personnel expenses	592.23	15.66	0.07	362.50	9.58	0.04
Rental costs	1,401.56	68.04	0.17	1,553.52	75.41	0.19
Costs of materials	1,605.67	31.51	0.19	1,797.12	35.27	0.22
Deposits	199,921.30	29.64	23.92	63,871.16	9.47	7.64
Loans	15,284.20	16.69	1.83	9,271.62	10.12	1.11

Note. The savings bank has a total business volume of around USD 835.66 million.

5. CONCLUSIONS

This paper evaluates the operating performance of a German savings bank's branches using the nonparametric data envelopment analysis (DEA) methodology. For the purpose of exploring whether the choice of output specification exerts significant influence on our empirical results, the output levels are measured by two alternative ways – the production approach as well as the intermediation approach. In addition to the identification of inefficient branches, the study breaks down the constituent components of operating efficiency, investigates scale properties, estimates the potential resource savings and output increments and, in association with management, examines the inefficiency problems in depth for each less-productive branch.

The main results indicate that out of the branch sample, two thirds are identified as being relatively inefficient. In general, the operational inefficiencies result mainly from a greater degree of wasteful overuse of resources and from a smaller degree to operating at the wrong scale. Of those, around 75.0% to 87.5% are detected to be operating at IRS, meaning that increasing their operational scale would be a way to improve performance. On the presumption that the less-productive branches could become as efficient as the best practices in the sample, the savings bank could annually achieve a total saving on operating expenses of between USD 3.6 and 3.7 million without sacrificing the current service level; on the other hand, without consuming any additional resources, this savings bank could attract added deposits of between USD 63.9 and 199.9 million and provide additional loans of between USD 9.3 and 15.3 million. The amounts of potential improvements are based on the achieved performance of other similar branches characterized as the best practices, so they are quite suitable for target setting and provide helpful information for resource reallocation and planning strategy in order to achieve higher operating efficiencies. Furthermore, the identified less efficient branches exhibit the following disadvantages: weaker managers, diseconomy of scale, and unfavorable location. The findings were consistent with the conceptions of management and the study provided verification of their perceptions.

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