EFFICIENCY BENCHMARKING OF BANK BRANCHES FOR STAFFING PURPOSES USING DEA

Paul Gemmel
Faculty of Economics and Business Administration, Ghent University, Belgium
e-mail: paul.gemmel@Ugent.be

Filip Bourgonjon
Vlerick Leuven Gent Management School, Belgium
Abstract

Data Envelopment Analysis (DEA) is an efficiency benchmarking technique that is frequently used to study the relative performance of bank branches. In this paper we show how results of a DEA study - including 1720 bank branches - are transformed into a practical tool supporting district managers of the bank in evaluating the performance of their branches in function of staffing decisions. This paper describes the several steps in this transformation process: determining input, output and environmental variables; selecting different efficiency perspectives such as operational efficiency, commercial efficiency and profitability; classifying branches according to these different perspectives in a 2x2x2 matrix; comparing the DEA results for each branch and to the results based on a commonly used performance ratio (gross margin per FTE).

Although the three different efficiency perspectives are defined before running the DEA model, the question remains whether these perspectives are meaningful or not. A log-linear and odds-analysis suggest that there is a very strong relationship between operational efficiency and commercial efficiency when only a dichotomous “efficient/inefficient” classification is considered.

Using regression and looking at the relationship between the gross margin per FTE and the efficiency scores of the 628 branches in the worst performing category, a high $R^2$ was found. The quite good correlation between this commonly used performance measure and the DEA scores in the different efficiency perspectives supported the bank’s acceptance of the results of the study.

Using DEA, the bank is now able to make a distinction between different groups of branches based on their performance. In the hands of a district manager, who has a very good
knowledge of each branch in his district, the 2 by 2 by 2 matrices are a very useful tool for helping them select branches that are candidates for FTE reduction and those that could use more FTE.

**Key-words:** benchmarking, data envelopment analysis, staffing, banks
In a competitive environment, companies constantly look for ways to improve their operations. In this respect, benchmarking can be used to determine best practices, that can be incorporated into a company’s own practices. A difference can be made between internal and external benchmarking, depending on the focus of the benchmarking study. A company, with similar homogenous units has the opportunity to perform an internal benchmarking analysis, comparing the practices of the various units. Comparing branches of different banks is an example of external benchmarking, while comparing the branches of one bank is internal benchmarking. The focus of this study is on internal benchmarking of the branches of one bank.

In starting-up a benchmarking study, it is important to identify what the goals of the benchmarking study are. Goals can be very diverse, ranging from investigating to what extent branches have attained pre-determined goals (Lovell et al., 1997) to evaluating the performance of bank branch managers (Sherman et al., 1995) and employees (Schaffnit et al., 1997). The goal of this study was to develop a reference model to support district managers of a large bank in evaluating the performance of their bank branches in order to make staffing decisions. Typically, on a district level, managers are confronted with the question how to re-allocate staff between branches? To maximise the profitability of the bank, each FTE staff must generate as much added value as possible. The statement ‘as much added value as possible’ introduces two major problems for the district managers:

1. ‘value’ is a multi-dimensional concept that includes efficiency and profitability. Furthermore many environmental variables (such as competition and market potential) can have an impact on the performance of bank branches and their staff.
Bank management does not have an absolute norm for what constitutes good or bad practice. The alternative is to develop staffing norms in a relative way by looking at other similar service units. Because no two service settings work exactly in the same way, the main task in this approach is to prove the comparability of the service settings. One of the major problems in staffing decision is being sure that the diversity of activities and of ‘uncontrolled’ external factors is taken into account. Furthermore in order to develop relative staffing norms, a sufficiently large number of comparable units is required. In general, service firms have a comparative advantage over manufacturing firms in performing relative efficiency benchmarking because they have a much larger network of service delivery sites (McLaughlin et al., 1990).

According to Berger et al. (1997), one way to classify branches as best or worst practice is to use a frontier analysis techniques such as DEA. In this paper we show how DEA was applied in a very large Belgian bank (1720 branches) to support district manager of the bank in allocating staff between the various branches. The four steps in the study are as follows:

1. We determined the different input, output and grouping variables in the DEA model. In line with the different perspectives towards the working of bank branches (the production perspective and the intermediation perspective (Thanassoulis, 1999)), three different perspectives were selected: operational efficiency, commercial efficiency and profitability. Input and output variables were defined for each perspective. Special attention was given to the environmental variables (such as competition and market potential).

2. After running the DEA models, we classified the branches in a 2x2x2 matrix based on the three perspectives and whether or not the branches were efficient. An important question raised by bank management was whether an inefficient branch in the
operational efficiency perspective was also inefficient in the profitability perspective. In other words is there a positive relationship between operational efficiency and profitability as suggested in the study of Oral et al. (1990)?

3. To make the advantages of this reallocation visible, we linked the 8 categories of the DEA analysis with a performance ratio historically used in the bank (in this case the gross margin per FTE). This paper looks at the relationship of this ratio and the DEA results on a branch level.

4. We classified the branches on a district level. In the hands of a district manager, who knows each of the branches in his district very well, the 2 by 2 by 2 matrices are a very useful tool for helping the district managers to select branches that are candidates for FTE reduction and those that could use more FTE. This paper shows how the tool is used.

The development and application of a DEA-based tool in a specific decision area (re-allocation of staff on a district level) in a bank with a very large number of branches (1720) are the specific contributions of this paper to the community of DEA researchers in banking. Before we describe the four steps of the study (outlined above) in more depth, we briefly review the literature on techniques for relative efficiency benchmarking, specifically applied to bank branches.

Techniques for relative efficiency benchmarking of service units
Several techniques are available for relative efficiency benchmarking of service units. The most basic technique is the ratio-analysis, where the ratio of one output to one input is compared between several bank branches. Efficiency is defined as (Avkiran, 1999):

\[
\text{Efficiency (branch 1)} = \frac{\text{Output}}{\text{Input}}
\]

Depending on what kinds of output and input measures are used, a distinction can be made between economical efficiency and technical efficiency. In the former, prices play a crucial role, while the latter looks at the amount of work produced with a certain amount of input (Norman et al., 1991).

So, the relative efficiency of branch 1 is the result of the comparison of the efficiency of branch 1 to the efficiency of another branch (e.g. branch 2):

\[
\text{Relative efficiency} = \frac{\text{efficiency(branch1)}}{\text{efficiency(branch2)}}
\]

If branch 2 is a best practice (i.e. in this case branch 2 produces more output with the same amount of input than branch 1), branch 2 forms the frontier for branch 1 and the frontier efficiency of branch 1 is determined. Depending on how much shape is imposed on the frontier, a distinction is made between non-parametric and parametric frontiers (Berger et al., 1997). Non-parametric approaches such as DEA, do not impose any particular functional form that presupposes the shape of the frontier (Berger et al., 1997, p.179). The non-parametric DEA approach is more preferred than parametric approaches when the frontier analysis focuses on branch performance within a single bank in order to improve managerial performance (Berger et al., 1997, p.203). The greater popularity of DEA in this case is also
confirmed in more recent studies of branch efficiency (Thanassoulis, 1999; Zenios et al., 1999; Soteriou et al., 1999; Athanassopoulos et al., 2000). Therefore this study uses DEA as the basic efficiency benchmarking technique. On the other hand, one must be aware that these non-parametric approaches do not allow for random errors owing to luck, data errors and other measurement errors (Berger et al., 1997, p.179). This implies that data and measurement errors must be avoided as much as possible.

Using DEA, a best-practice function is empirically built from observed inputs and outputs. Linear programming is used to derive this best practice function. The objective is to maximise a service unit’s efficiency - expressed as a ratio of outputs to inputs- by comparing a particular unit’s efficiency with the performance of a group of similar units delivering the same service. Some of the units are evaluated as 100% efficient as compared to the other units. These 100% efficient units are said to lie on the efficient production frontier. Other units have an efficiency rating of less than 100% and are considered to be relatively inefficient. DEA further indicates how an inefficient service unit can improve its performance. By identifying a reference set of efficient service units for each inefficient unit, one can determine how the amount of some of the input factors must be reduced to attain the same level of output in an efficient way. In this way, the efficient production frontier represents a standard of performance that the units not on the efficient frontier could try to achieve. In other words the efficient frontier envelopes (encloses) all the data points. This is the origin of the term “data envelopment analysis” (DEA).

Since the development of the DEA model by Charnes, Cooper and Rhodes (CCR)(1978), various researchers have developed many different models for specific applications. In this study, input-oriented as well as output-oriented CCR models are used. Selecting a CCR model
means that constant returns to scale are assumed. On a bank branch level, constant returns to scales are preferred, because they are more in line with the experience of the bank branch managers (Athanassopoulos et al., 2000). The mathematical formulation of the CCR models is described in the Appendix.

**Efficiency benchmarking of bank branches using DEA: a literature review.**

In their comprehensive overview of frontier efficiency in banking, Berger and Humphrey (1997, p.193) recognize thirteen different studies dealing with improving managerial performance in the bank branches of one bank. Avkiran (1999) lists 16 principal articles on use of DEA in branch banking. Since these reviews, many new studies of managerial performance in bank branches have been published (Frei et al., 1999; Golany et al., 1999; Kantor et al., 1999; Zenios et al., 1999; Soteriou et al., 1999; Athanassopoulos et al., 2000). Most of these studies classify branches as best or worst practice. Based on this classification, branches are evaluated and managerial actions can be taken. Examples are: the evaluation of the managerial practices (Sherman et al. 1995), of the employees working in the branch (Schaffnit et al., 1997), and the re-allocation of resources (Al-Faraj et al., 1993). This study also looks at the re-allocation of employee resources.

More specific goals of the DEA studies are, for instance, the evaluation of output measures (incorporated in targets for the branches) (Lovell et al., 1997) and the evolution of branch efficiency over the years (Athanassopoulos et al., 2000).

It is interesting to observe that some of these studies look at branch efficiency from different perspectives (Athanassopoulos, 1997; Soteriou et al., 1999). Soteriou for example, uses different efficiency dimensions based on the Service Profit Chain (Heskett et al., 1994) and places branches on two-dimensional spaces of performance – operational efficiency versus
profitability, for instance-. In this way, one can identify the concerted managerial actions needed to improve performance. Several studies try to get more detailed insight into branch efficiency. The study of Frei et al. (1999) looks at one process (open checking account process) in 124 bank branches and takes into account the process design parameters. Examples of process design parameters are: service level attempted and the ways in which firms motivate their employees. Frei et al. clearly show in their study that differences in process design may be a major cause of differences in production efficiency between bank branches.

An important distinctive characteristic of this study is the very large number of bank branches involved (1720 branches $^1$) while many of the studies mentioned have no more than 100 branches $^2$. This large number is important, because a major problem identified in the overview of Berger et al. (1997, p.204) is the relatively large proportion of branches that are identified as relatively efficient. This is due to the fact that the number of branches in those studies is relatively small compared to the number of inputs and outputs included. The large number of branches gives us the opportunity to introduce a large number of input and output measures. It also introduces the necessity to control for different environmental factors such as competition and market potential. The next part of this paper will develop these issues.

The bank in this study is a recent merger of two former banks. At the moment of this study, the differences between branches based on their affiliation with one or the other of the two former banks was still very clear. Therefore, with bank management, we decided to do the analysis separately for the two groups of branches (based on their former affiliation). One

$^1$ The branches with an autonomous statute are not included in the study.
former bank (called bank A) has 1058 branches. The other former bank (called bank B) has 662 branches. These numbers are still larger than those in many of the studies mentioned. In the smaller group (bank B), the ratio of units to (inputs x outputs) is still more than 10, a figure that is higher than most of the studies mentioned in Avkiran (1999). Using the same efficiency benchmarking technique in two different groups of branches allows us to see how the technique works in different environments.

**Measuring input and output**

One of the most important -but at the same time most controversial- elements of the DEA model development is the definition of the input and output variables used. Defining inputs and outputs depends on how one looks at the activities of a bank branch. Generally, on a bank branch level, a distinction is made between the production perspective and the intermediation perspective (Thanassoulis, 1999). From a production perspective, a bank branch uses physical resources (such as labour, capital and space) and transforms them into transactions of different types. In the intermediation perspective, a bank branch acts as an intermediary collecting funds in the form of deposits and transforming them into loans and other income-earning activities (Thanassoulis, 1999). Although there are other perspectives, most studies on a bank branch level can be situated within the production efficiency and intermediation efficiency perspectives (Athanassopoulos, 2000).

How the different efficiency perspectives are measured depends on the aggregation level on which the analysis takes place. In this paper, the level of analysis is the bank branch, which is different from the bank level and from the level where processes within branches are studied. Measurement always includes the definition of input and output variables. A great variety of

---

2 There are some exceptions such as the study of Lovell et al., 1997 involving 545 branches.
input and output variables are proposed in several bank branch level DEA studies. As to (discretionary) input variables, the amount of time bank personnel spend performing certain activities can be used (Golony et al., 1999; Frei et al., 1999), while others use the number of full-time equivalent (FTE) personnel (Zenios et al., 1999; Soteriou et al., 1999). Other input variables are proposed, such as: size of the branch (Kantor et al., 1999; Golony et al., 1999; Zenios et al., 1999); equipment of bank branches, such as computer terminals (Zenios et al., 1999; Soteriou et al., 1999). Zenios et al. (1999) and Soteriou et al. (1999) use the number of accounts as an input measure. Their main argument is that the clientele infrastructure is closely linked to a specific branch, and it changes very slowly with time so that it can be considered as a part of the internal environment (Zenios et al., 1999).

As to output variables, a distinction is made between short-term and long-term output measures. For instance, Golony et al. (1999) used total loans and total deposits (each divided into different components) as short-term output measures, and measurements of customer satisfaction and the branch’s contribution to the reputation of the bank in the region as long-term output variables. Other output variables are: total amount of work produced by the branch (measured in hours)(Zenios et al., 1999; Soteriou et al., 1999), profits (Soteriou et al., 1999), and number of accounts (Kantor et al., 1999).

It is remarkable that the number of accounts is used as an input variable as well as an output variable. The selection of the right input and output variables can have a significant impact on the results of the study. For example, Athanassopoulos (2000) shows that using the number of accounts, average size of accounts or volume of accounts lead to totally different DEA results. Which dimension is used in the study depends on the ultimate goals of the study.
Because this study aims at developing a tool for reallocating employees between bank branches, the main focus is on how efficiently the available full-time equivalent employees are deployed in a branch. Therefore, the only discretionary input variable is the budgeted FTE employees in each branch. The efficiency of these FTE is looked upon from three different perspectives: the operational perspective, the commercial perspective and a profitability perspective. The operational perspective as well as the commercial perspective approach the previously defined production perspective. The former looks at how the FTE employees produces transaction of various types (such as the number of loans and the number of deposits, see Table 1), while the latter looks at how these FTE employees develop a customer base in terms of volume and the number of different products and services these customers use (the so-called “customer equipment”). The main reason for introducing the commercial perspective is that the operational perspective gives the same treatment to all accounts (regardless of the kind of customer behind it). It is quite clear that different categories of customers can be distinguished in terms of customer equipment they use in the same bank. Because the operational and commercial perspectives are a flow concept (number of accounts or transactions or customers per FTE), they do not include the monetary value of the accounts and certainly not the margin on these products. Therefore, profitability was introduced as a third perspective. It relates to the intermediation approach (defined above). This means that monetary values (for instance, of savings accounts) are introduced here.

One of the basic assumptions in relative performance measurement is that the bank branches compared are homogeneous. This means that the operational goals and characteristics of these units must be comparable. There are many (external) environmental elements that can have an impact on the operational characteristics of a bank branch, and thus influence its efficiency. For instance Zenios et al. (1999) distinguish between urban, rural and tourist branches, and
large, medium and small branches. In their study they found that rural branches are less efficient than urban branches, and that tourist branches are more efficient, on average, than comparable branches in the urban areas, -but this is only true during the high season (summer months). In order to account for these environmental elements, two strategies can be used. The first one is to split the total sample of branches into smaller, homogeneous segments and then to perform DEA in each segment. The second strategy is to use non-discretionary variables.

The problem with segmentation is that many different environmental elements can be used as segmentation criteria. Athanassopoulos (1998) recognizes four categories of environmental elements: level of competition, size characteristics of the branch, the potential market, and the types and average size of accounts held in the branches, and the affluence of the surrounding area. This approach led to smaller groups of branches (per segment), which can introduce the problem of insufficient units per group. Because many different criteria can be used for segmentation, cluster analysis is proposed to reduce this number (Athanassopoulos, 1998).

Another problem of performing DEA in different groups, is that the results cannot be compared between groups (segments). Zenios et al. (1999) have developed a three-step procedure to make the DEA results comparable across groups. Nonetheless the DEA is still performed separately within the different groups.

Using non-discretionary input variables is another way to control for these environmental variables. Non-discretionary input variables are still taken into account within the constraints of the DEA model, but they are not proportionally reduced (because management has no control over them). In other words, these input variables play a role in determining the reference set of efficient units, but they do not impact the final efficiency score (once the reference set is determined). In the Appendix, the effect of introducing non-discretionary input variables is mathematically shown (see model 4).
In this paper, the use of non-discretionary input variables is preferred over segmentation. The main reason is that the bank management wanted to keep branches together as much as possible. The introduction of a large number of non-discretionary input variables is also possible because of the large number of bank branches involved.

Table 1 gives an overview of the different input and output variables used in this study, linked to the different efficiency perspectives. It is important to note that the list is the result of a six-month discussion between the academic group and the bank management. Some variables are included in the list because of their ‘psychological value’ rather than their added value in the model. That is why some highly correlated output variables are retained in the list, although it is known that such highly correlated variables do not add value to the DEA results. A second remark is that some variables, such as customer satisfaction or quality of services, are not included in the list. The main reason is that quality is not easy to measure, and that moment was not the right time to spend a considerable amount of money collecting these data. In other words, data availability also determines, in one way or another, the variables included in the study.

- INSERT TABLE 1 ABOUT HERE –

A major challenge in collecting the data for this study was the differences in information systems and data availability in both former banks (bank A and Bank B). Therefore a lot of time was spent in making data uniform for all branches, regardless of their origin. A six-month pilot study with 180 branches was performed. Before running the DEA models, the data were analysed with classic statistical methods. Several iterations were required to come up with acceptably valid data. During this process, there was also a lot of discussion about the
input and output variables. It became clear in this first stage that there were significant differences between the branches of the two former banks. Therefore, we decided to do a separate analysis for the branches of the two former banks (A and B). A working group consisting of bank staff and management, district managers and the academic team was formed to conduct the whole study. This team ended up with data that was comparable across the two former banks and that was valid enough to be used in the DEA.

The results of applying DEA in the different efficiency perspectives

Table 2 shows the general DEA results for both former banks A and B. The mean operational efficiency in bank A is 76.29%. This implies an average inefficiency of 23.71%. The average commercial efficiency in bank A is higher than the operational efficiency, and the average profitability score in minimisation mode is lower than operational efficiency. The average profitability in maximisation mode is much higher. Note that the minimisation and maximisation models do not deliver the same efficiency scores due to the use of non-discretionary input variables.

The same ranking of the three efficiency dimensions can be found in bank B. Operational efficiency, commercial efficiency, and profitability in bank A are lower than the respective efficiency dimensions in bank B. Notable is the very large difference between the profitability score of bank A and that of bank B. If these scores are compared to the 188 different annual average efficiency estimates in the review study of Berger et al. (1997), then all our scores, with the exception of the ‘profmins’ score of bank A, lie between the interval formed by the mean of 79% and the standard deviation of 13%.³
The higher profitability score in bank B (in minimisation mode as well as in maximisation mode) reflects a much higher homogeneity of the profitability results in bank B than in bank A. Bank management confirms that bank B has a management control system that uses some of the current profitability output measures as performance indicators.

An important question raised by bank management was whether there is more chance that a best practice branch in one perspective is also a best practice branch in another perspective? Is there a positive relationship between operational efficiency and profitability as suggested in the study of Oral et al. (1990)? If there is a positive relationship between operational efficiency, commercial efficiency, and profitability, one can argue that the ultimate goal of each branch is to attain a state where it is efficient in the three perspectives. When there is not a positive relationship, priorities must be set as to what kind of perspective is preferred in evaluating the performance of the bank branches.

To answer this question, all branches (in bank A and bank B) are classified in different categories in Tables 3 and 4 based on whether they are efficient or not in the three perspectives. In order to analyse the categorical data in Tables 3 and 4, we calculated the marginal odds, the conditional odds ratio and the partial odds ratio (see Table 5) as well as the overall, first order, second order and third order effect of the loglinear model (see Tables 6 and 7) (Knoke et al., 1990).

3 In these 188 estimates, parametric and non-parametric methods are used.
Several conclusions can be made based on Table 5:

- The marginal odds teach us that the probability of being inefficient in each of the three perspectives is much higher than being efficient. In fact 36%, 37% and 17% of the branches are, respectively, operationally efficient, commercially efficient, and profitable in bank A. In bank B these percentages are substantially higher. This means that many more branches are 100% efficient in bank B than in Bank A. One explanation might be that in bank A there is a smaller group of branches that excel on any of the different output measures in each of the DEA models, while in bank B different branches excel on different output measures. Knowing that many DEA studies mention the problem of a great percentage of efficient units (at least more than 50% of the involved sample), the higher percentage of efficient units in bank B is not unusual.

- Looking at the odds ratios, there is a significant positive relationship between commercial efficiency and operational efficiency. In bank A, the odds of having a commercially efficient branch rather than a non-commercially efficient branch is 12.71 times greater for those that are operationally efficient than for those that are not operationally efficient. The conditional odds-ratios show us that on average in bank A, the probability of being commercially efficient rather than commercially inefficient is 11.45 times greater for those branches which are operationally efficient rather than operationally inefficient. Bank B also shows a high figure for this relationship. To a lesser extent, but still significant, there is a positive relationship between being profitable and, respectively, operationally efficient and commercially efficient (in bank A as
well as in bank B). In bank A, on average, the odds of being operationally efficient rather than operationally inefficient is 3.66 times greater for profitable branches than non-profitable branches. This average is twice as high in bank B. Furthermore on average the positive relationship between operational efficiency and profitability in bank B is not as strong as the one between commercial efficiency and profitability, while in bank A it is the other way around (see partial odds ratios in Table 5). It is important to note that no causal relationship is assumed.

In general the results of the DEA analysis in bank A and bank B lead to the same conclusion, although the level of efficiency scores in bank B are higher than in bank A. This might be due to more homogeneity in the operations of bank B, but this could also be the consequence of the smaller number of units in bank B as compared to bank A. Because the results are quite similar for bank A and bank B, we limit this discussion to bank A (see Table 6).

- INSERT TABLE 6 ABOUT HERE -

The multiplicative parameters of the loglinear model give approximately the same message. If the multiplicative parameter is smaller than 1, this means that the effect occurs less frequently than can be expected on the basis of the lower order effects. For instance operational efficiency, commercial efficiency, and profitability occur, on average, respectively 1.15, 1.22 and 2.16 less often than can be expected on the basis of the overall effect. The interesting point is that the current value of cell frequency can be decomposed using these multiplicative parameters of the log-linear model. For example, the cell frequency of 628 (see Table 3) can be written as:
Where $\mu$ is the overall effect; $\tau_{0}^{O} \tau_{0}^{C} \tau_{0}^{P}$ are the first order effects for the condition of being inefficient in, respectively, the operational efficiency, commercial efficiency, and profitability dimensions; $\tau_{00}^{OC} \tau_{00}^{OP} \tau_{00}^{CP}$ are the second order effects for the condition of being inefficient; and the last term is the third order effect. If all these terms are filled in for bank A, this gives the following results:

$$628 = 67.85 \times 1.15 \times 1.22 \times 2.16 \times 1.84 \times 1.38 \times 1.22 \times 0.98$$

In other words, the most important effects determining the high number of units that are inefficient in the three perspectives are: the first order effect of profitability (2.16) and the second order effect of being operationally inefficient and not commercially efficient (among the branches that are profitable and non-profitable) (1.84). The strong second order effect also suggests the strong relationship between the operationally and commercially efficient perspectives (see also the odds-ratio analysis). Operational efficiency and commercial efficiency seem to give the same kind of information in order to classify branches as efficient and inefficient, while profitability is a different dimension.

The results of the odds-analysis and the loglinear analysis suggest strongly that commercial and operational perspectives are very similar. In other words, commercial efficiency does not add much value to categorising branches when they have already been classified based on operational efficiency. Therefore, the academic team suggested using a two by two matrix to
classify branches instead of the original two by two by two matrix (see Table 3).

Nevertheless, bank management decided to retain the original 8 categories and two sets of 2 by 2 matrices (see Figure 2). The main reason is that separating operational and commercial efficiency allows one to collect more information on potential improvements (i.e. the variable $\theta_j$ in the dual problem formulation of the DEA model, see the Appendix).

**Using DEA to reallocate staff**

Table 7 shows some key characteristics of the bank branches in the 8 different cells of Table 3. The average operational efficiency of category 1 is 10% lower than the general average. Using quartiles, 75% of the branches in this category have an operational efficiency lower than the average. Note also the large difference between the profitability in the minimisation mode and the maximisation mode. The maximisation mode is used to classify branches in each of the 8 cell frequencies. The minimisation mode is used to look for FTE reduction.

In the last column of Table 7, the average gross margin per FTE is listed for each of the 8 categories. The gross margin per FTE is compared to the average gross margin per FTE of category 1 (which has a base value of 100%). Gross margin per FTE is a common, important ratio used in the management control system of a bank. In category 8 the gross margin per FTE is approximately 50% higher than in category 1.

In the lower part of Table 7, we learn that, on average, the gross margin per FTE is 18% higher in category 20 (which encompasses categories 2 to 8 in the upper part of the table).

---

4 Because the results are quite similar for both banks, we limit the following analyses to bank A.
In focusing on those branches that are inefficient in the three dimensions, the next question is how much FTE can be re-allocated. In fact, each of the three efficiency models (operational efficiency, commercial efficiency and profitability in the minimisation mode) suggests an FTE reduction in order to become efficient. For instance, one branch could have the following DEA score: 50% for profitability, 60% for operational efficiency, and 70% for commercial efficiency. Because FTE is the only discretionary input variable in each of the models, this branch could reduce its FTE by, respectively, 50%, 40% and 30% according to the three models. The key question is then: which figure is the right one? The average? To answer this question, we looked at the relationship between the different efficiency dimensions. Here again, we detected a much stronger positive correlation between operational and commercial efficiency (see Table 8), while the correlation between operational efficiency and profitability, and between commercial efficiency and profitability is much lower. This again indicates that operational and commercial efficiency are indicators of one dimension and only two dimensions or perspectives can be distinguished: efficiency and profitability.

Nonetheless, bank management decided to keep the three dimensions in the model and to use a very conservative rule concerning FTE reduction: FTE can only be reduced when the branch is inefficient in each of the three efficiency dimensions at the same time. In other words, only the branches in category 1 (Table 7) are candidates for FTE reduction.

In order to make the advantages of this reallocation visible and acceptable, it is very useful to link the 8 categories of the DEA analysis with a commonly used performance ratio, in this case, gross margin per FTE. In general, the correlation between gross margin per FTE and the different efficiency dimensions are quite strong (Table 8). The relationship between gross
margin per FTE and the profitability dimension in minimisation mode is the strongest one. Figure 1 shows the correlation between these two variables. Using linear regression with gross margin per FTE as dependent variable, and the profit minimisation score as independent variable, we find a $R^2$ of 56%. If the operational and commercial efficiency dimensions are introduced, we find a $R^2$ of 72%. The regression models suggest that, on average, to become 100% profitable, these branches should double their current gross margin per FTE.

In this way it becomes clear that, on average, a branch in category 8 produces more gross margin than a branch in category 1. Taking into account that the category 8 ‘star’ branches may be confronted with understaffing (which can have a negative impact on their future potential), these classifications of branches can give a first indication of the re-allocation of staff between branches. This is certainly the case when these matrices are combined with institutional experience. Therefore, the classification of branches is done on a district level. In the hands of a district manager, who has a very good knowledge of each of the branches in his district, the 2 by 2 by 2 matrices (as shown in Figure 2) are a very useful tool for helping the district managers to select branches that are candidates for FTE reduction and branches that could use more FTE.

Because of confidentiality reasons, we cannot show the results of this regression analysis.
Conclusion, Implications and further research

The goal of this study was to develop a reference model to support district managers of a large bank in evaluating the performance of their bank branches in order to make staffing decisions. Typically on a district level, managers are confronted with the question: how to re-allocate staff between branches? To maximise the profitability of the bank, each FTE staff must generate as much added value as possible. The main problem is that ‘value’ is a multidimensional concept that includes efficiency and profitability. Furthermore many environmental variables (such as competition and market potential) can have an impact on the performance of bank branches and their staff.

According to Berger et al. (1997), one of the best uses of frontier analysis in managerial applications is to rank bank branches and to determine together with internal measures of performance branches that can be classified as best or worst practice. For bank management, it is very important to know whether or not bank branches are efficient. Because three different perspectives of efficiency are used in this study, and in each perspective a branch can be efficient or not, 8 categories (groups) of branches are distinguished. Although the different perspectives are defined before the DEA, there remains the question of whether these three dimensions are meaningful or not. The loglinear and odds-analyses suggest that there is a very strong relationship between operational efficiency and commercial efficiency when only a dichotomous efficient/inefficient classification is considered. Nevertheless bank management decided to keep the three dimensions in the analysis to obtain more information.

It has already been suggested that it is always interesting to link the DEA results with the commonly used performance indicators. In looking at the relationship between the gross
margin per FTE and the efficiency scores of the 628 branches in category 1 using regression, a high $R^2$ was found. The quite good correlation between the commonly used performance measure and the DEA scores in the different efficiency perspectives supported the bank’s acceptance of the results of the study.

Using Data Envelopment Analysis, the bank is now able to make a distinction between different groups of branches based on their performance. In the hands of a district manager, who knows each of the branches in his district very well, the 2 by 2 by 2 matrices are a very useful tool for helping them to select branches that are candidates for FTE reduction and those that could use more FTE. As a very conservative rule, bank management proposed that only branches in category 1 (which are inefficient in each of the three dimensions) are candidates for FTE reduction. The FTE of these branches should be reallocated to branches that are highly profitable in terms of gross margin per FTE (category 8) and that risk being curbed in their growth due to shortness of staff.

The use of a non-parametric technique such as DEA for efficiency benchmarking delivers some advantages and disadvantages:

- DEA allows one to introduce multiple input and output measures (without the need to convert them to one common denominator). A particularity of the DEA technique is that, through the mechanism of non-discretionary input variables, grouping variables such as competition and market potential can be brought into the model. The advantage of doing this is that we don’t need to split the total sample into subgroups and apply a DEA in each subgroup. It was the very explicit direction of bank management to keep the total group of branches together as much as possible.
• DEA allows one to make a distinction between 100% efficient and inefficient (< 100%). This kind of binary thinking (efficient or not) is very useful, certainly when, in combination with odds- and loglinear analyses, insights into the chance of having an efficient branch can be calculated.

• By comparing itself with reference branches (which are 100% efficient), an inefficient branch gets information about the areas and the amount of potential improvement it can attain. Reference branches for a particular branch are those branches that best approach the output/input ratios of the particular branch. One must be careful that the group of reference branches does not contain a-typical branches (which may not be used for comparison). It is a disadvantage of DEA that it is very sensitive to extreme points (outliers). In preparing the database, bank management spend a lot of time identifying those branches that cannot be used as reference units.

• In many DEA studies, a large number of branches are considered to be efficient. To some extent, this is also the case in our study. For instance in bank B approximately 50 % of the branches are efficient. For the group of efficient units, there is no information on which units are even better than others.

• Compared to parametric frontier analysis, DEA has the advantage of not imposing a structure on the frontier, but the disadvantage is that DEA does not allow for random error owing to luck, data problems, or other measurement errors (Berger et al., 1997).

• DEA measures the efficiency of branches relative to each other. There is no statement about the absolute efficiency. Even the best branches can perform weakly in an absolute view.
At this moment four major issues for further research are brought forward by bank management:

- Explanation of the different efficiency scores of bank branches. Are branches with a specific type of activity (e.g. tourist branches) more inefficient? Is there a difference between rural and urban branches? In order to answer these questions some additional data collection is necessary.

- The effect of scale. In this study we assumed that there is no scale-effect on the branch level. Bank management supports this view. Nonetheless based on the previous analyses we detect some indications of the existence of a scale-effect. Further research must show what kinds of scale-effects are present.

- Comparison between years. The goal of the bank is to repeat the study each year and to compare the performance of branches over years. Because of the shift in frontier from one year to another, we need to use an appropriate methodology to do this longitudinal analysis. In the literature, Malmquist DEA has been proposed as one of the possible techniques (Färe et al., 1994).

- Because the bank is a merger of two former banks (A and B), the analysis in the following years must be performed for all bank branches together (regardless of their origin).

The DEA-based tool proposed in this paper can be used in other service environments with a large network of units. However one must be aware that collecting valid data is a major effort and presupposes the availability of good information systems. Such a study is time-consuming and requires significant effort, involvement and support from bank management.
REFERENCES


Table 1. An overview of the variables used in the different DEA models (Y indicates that the particular variable is included in the respective model).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description of the Operation</th>
<th>Operation</th>
<th>Commercial</th>
<th>Profitability</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDBRANC</td>
<td>Unique identification number of the</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>FTE_THEOR</td>
<td>theoretical (budgeted) number of FTE allocated to a</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>PROFILESTAF</td>
<td>the extent to which a branch has an average profile of</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>COMPETITION</td>
<td>indicating the presence of branches of other banks in</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>TOTSAFE</td>
<td>total number of safes in the</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>ADVROOM</td>
<td>number of rooms in the branch available for giving</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>SELFTOTA</td>
<td>number of ATM</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>POTMA</td>
<td>total market potential (for different types of</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>CREDC_BE</td>
<td>the degree of authority to grant</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>FLUXMEA</td>
<td>the mean flux per</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>COUNTERTRANS</td>
<td>the number of counter</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INVESTMENT</td>
<td>number of investments (in stocks,</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CREDIT</td>
<td>number of credits granted to</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CREDIT_P</td>
<td>number of credits granted to professionals and small</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FINCINSU</td>
<td>number of financial</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NFINCINSU</td>
<td>number of non-financial</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACCOUNTS</td>
<td>number of new</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROCES</td>
<td>differences in process (transactions) in bank A and bank</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IR1D_2</td>
<td>Individuals Retail equiped in 1 or 2</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IR3D_4</td>
<td>Individuals Retail equiped in 3 or 4</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRHPI1D_2</td>
<td>Individuals Retail High Potential equiped in 1 or 2</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRHPI3D_4</td>
<td>Individuals Retail High Potential equiped in 3 or 4</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PS1D_2</td>
<td>Professionals &amp; Small business customers equiped in 1or 2</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PS3D_4</td>
<td>Professionals &amp; Small business customers equiped in 3or 4</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSP1D_2</td>
<td>Professionals+ &amp; Small business high potentials equiped in 1 or 2</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSP3D_4</td>
<td>Professionals+ &amp; Small Business High Potentials equiped in 3 or 4</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAV</td>
<td>Save &amp; Invest: absolute</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAVI_growt</td>
<td>Save &amp; Invest: growth versus year</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOA</td>
<td>Loans: absolute</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOAN_growt</td>
<td>Loans: growth versus year</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Gross margin: absolute</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AB_growt</td>
<td>Gross margin: growth versus year</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2. The average DEA efficiency scores for BANKS A and B and the different efficiency dimensions

<table>
<thead>
<tr>
<th></th>
<th>No of branches</th>
<th>Commercial eff.</th>
<th>Operational eff.</th>
<th>Profitability min</th>
<th>Profitability max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank A</td>
<td>1056</td>
<td>78,03%</td>
<td>76,29%</td>
<td>63,42%</td>
<td>79,58%</td>
</tr>
<tr>
<td>Bank B</td>
<td>662</td>
<td>80,77%</td>
<td>78,53%</td>
<td>76,71%</td>
<td>88,84%</td>
</tr>
<tr>
<td>All Grps</td>
<td>662</td>
<td>79,09%</td>
<td>77,15%</td>
<td>68,54%</td>
<td>83,15%</td>
</tr>
</tbody>
</table>

Profitability min: the average DEA efficiency score for profitability based on a minimisation model.

Profitability max: the average DEA efficiency score for profitability based on a maximisation model.
Table 3. Number of branches in each category based on the three efficiency dimensions for BANK A (1056 branches)

<table>
<thead>
<tr>
<th>Operational efficient</th>
<th>Commercial efficient</th>
<th>Profitable</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>11</td>
<td>71</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>76</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td><strong>18</strong></td>
<td><strong>91</strong></td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
<td>87</td>
<td>14</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
<td>8</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td><strong>71</strong></td>
<td><strong>63</strong></td>
</tr>
</tbody>
</table>
Table 4. Number of branches in each category based on the three efficiency dimensions for BANK B (662 branches)

<table>
<thead>
<tr>
<th>Operational efficient</th>
<th>Commercial efficient</th>
<th>Profitable</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>41</td>
<td>104</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>44</td>
<td>15</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>85</strong></td>
<td><strong>119</strong></td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
<td>55</td>
<td>32</td>
</tr>
<tr>
<td>NO</td>
<td>No</td>
<td>31</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>36</strong></td>
<td><strong>92</strong></td>
</tr>
</tbody>
</table>
Table 5. Calculation of the odds

<table>
<thead>
<tr>
<th></th>
<th>BANK A</th>
<th></th>
<th>BANK B</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X 1/X (0)</td>
<td></td>
<td>X 1/X</td>
</tr>
<tr>
<td>marginal odds</td>
<td></td>
<td>Sig.</td>
<td></td>
<td>Sig.</td>
</tr>
<tr>
<td>operational efficiency (1)</td>
<td>0.36</td>
<td>2.80</td>
<td>0.45</td>
<td>2.25</td>
</tr>
<tr>
<td>commercial efficiency</td>
<td>0.37</td>
<td>2.73</td>
<td>0.54</td>
<td>1.85</td>
</tr>
<tr>
<td>profitability</td>
<td>0.17</td>
<td>5.86</td>
<td>0.47</td>
<td>2.14</td>
</tr>
<tr>
<td>Odds-ratio</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>commercial/operational (2)</td>
<td></td>
<td>12.71 0.08 0.000</td>
<td>10.48 0.10 0.000</td>
<td></td>
</tr>
<tr>
<td>profitable/operational</td>
<td></td>
<td>5.52 0.18 0.000</td>
<td>5.57 0.18 0.000</td>
<td></td>
</tr>
<tr>
<td>profitable/commercial</td>
<td>4.38</td>
<td>0.23 0.000</td>
<td>6.71 0.15 0.000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conditional on operational efficiency (3)</td>
<td>0.41 2.43 0.002</td>
<td>0.13 7.44 0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conditional on operational inefficiency</td>
<td>0.48 2.06 0.025</td>
<td>0.33 3.02 0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>partial odds ratio (4)</td>
<td>0.45 2.24</td>
<td>0.21 4.74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conditional on commercial efficiency</td>
<td>0.25 3.97 0.000</td>
<td>0.23 4.36 0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conditional on commercial inefficiency</td>
<td>0.30 3.37 0.000</td>
<td>0.57 1.77 0.085</td>
<td></td>
<td></td>
</tr>
<tr>
<td>partial odds ratio</td>
<td>0.27 3.66</td>
<td>0.36 2.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conditional on profitability</td>
<td>12.43 0.09 0.000</td>
<td>13.00 0.08 0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conditional on not profitability</td>
<td>10.54 0.09 0.000</td>
<td>5.27 0.19 0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>partial odds ratio</td>
<td>11.45 0.09</td>
<td>8.28 0.12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(0) If X is 0.36, then 1/X is 1/0.36 = 2.80
(1) Probability of being operational efficient rather than being operational inefficient = 278/778 (see Table 3) = 0.36
(2) In the total sample, the odds of having a commercial efficient branch rather than a commercial inefficient branch is 12.71 times greater for those that are operational efficient, than for those that are operational inefficient = (111+71)/(76+20)/(87+14)/(628+49) (see Table 3)
(3) For those branches that are operational efficient, the odds of being non-profitable rather than being profitable is 2.43 times smaller for those who are commercial efficient rather than commercial inefficient = (111/71)/(76/20) (see Table 3)
(4) On average, the odds of being non-profitable rather than being profitable is 2.24 times smaller for those who are commercial efficient rather than commercial inefficient = Square root from (0.41*0.48).
Table 6. Loglinear effects for Bank A: overall effect, multiplicative parameters (1e order, 2e order and 3d order)

<table>
<thead>
<tr>
<th>Overall effect (1)</th>
<th>67.85</th>
</tr>
</thead>
</table>

**Multiplicative parameters (1e order)**

<table>
<thead>
<tr>
<th>Operational efficient (2)</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>1.15</td>
<td>0.87</td>
</tr>
<tr>
<td>Commercial efficient</td>
<td>1.22</td>
<td>0.82</td>
</tr>
<tr>
<td>Profitable</td>
<td>2.16</td>
<td>0.46</td>
</tr>
</tbody>
</table>

**Multiplicative parameters (2e order)**

<table>
<thead>
<tr>
<th>Operational efficient (3)</th>
<th>Profitable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>No</td>
<td>1.38</td>
</tr>
<tr>
<td>Commercial efficient</td>
<td>No</td>
</tr>
<tr>
<td>Yes</td>
<td>1.22</td>
</tr>
<tr>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

**Multiplicative parameters (3e order)**

<table>
<thead>
<tr>
<th>Operational efficient (4)</th>
<th>Comm.eff</th>
<th>Profitable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>0.98</td>
<td>1.02</td>
</tr>
<tr>
<td>No</td>
<td>1.02</td>
<td>0.98</td>
</tr>
<tr>
<td>Yes</td>
<td>1.02</td>
<td>0.98</td>
</tr>
<tr>
<td>No</td>
<td>0.98</td>
<td>1.02</td>
</tr>
</tbody>
</table>

(1) This is the geometric mean of the raw frequencies in all cells; on average there are 67.85 branches in each cell. It is a reflection of the sample size.

(2) On average, operational inefficiency occurs 1.15 times more often than can be expected on the basis of the overall effect. It is the ratio of the geometric mean of the cell values of the operational efficient dimension (111;71;78;20) to the overall effect (67.85).

(3) On average the combination op.eff/not prof. among branches that are commercial and commercial inefficient occurs 1.38 times less often than can be expected on the overall effect and the one variable effect. It is calculated as the ratio of the geometric mean of those cell frequencies that are, at the same time, operational efficient and profitable (71; 20) and the product of the first order effect of operational efficiency (0.87) and profitability (0.46).

(4) The combination Op/com/prof occurs 1.02 times more often than can be expected on the basis of the overall, the first order and second order effect. It is calculated as the cell frequency which is operational, commercial efficient and profitable (71), divided by the overall effect (67.85), the first order effects of operational efficiency, commercial efficiency and profitability (respectively 0.87; 0.82 and 0.48) and second order effects operational/commercial (1.84), operational/profitable (1.38) and commercial/profitable (1.22).
### Some descriptive performance characteristics for each of the 8 cells

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>628,00</td>
<td>66,14</td>
<td>14,48</td>
<td>69,01</td>
<td>16,17</td>
<td>56,19</td>
<td>13,56</td>
<td>75,56</td>
<td>11,52</td>
<td>100,00%</td>
</tr>
<tr>
<td>2 N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>87,00</td>
<td>80,66</td>
<td>14,57</td>
<td>100,00</td>
<td>0,00</td>
<td>61,97</td>
<td>16,60</td>
<td>77,11</td>
<td>16,08</td>
<td>115,91%</td>
</tr>
<tr>
<td>3 Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>76,00</td>
<td>100,00</td>
<td>0,00</td>
<td>81,67</td>
<td>12,00</td>
<td>58,32</td>
<td>14,01</td>
<td>76,44</td>
<td>11,03</td>
<td>107,81%</td>
</tr>
<tr>
<td>4 Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>111,00</td>
<td>100,00</td>
<td>0,00</td>
<td>100,00</td>
<td>0,00</td>
<td>58,19</td>
<td>14,68</td>
<td>78,14</td>
<td>13,07</td>
<td>110,33%</td>
</tr>
<tr>
<td>5 N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>49,00</td>
<td>64,91</td>
<td>17,55</td>
<td>64,03</td>
<td>20,37</td>
<td>100,00</td>
<td>0,00</td>
<td>100,00</td>
<td>0,00</td>
<td>112,19%</td>
</tr>
<tr>
<td>6 N</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>14,00</td>
<td>73,17</td>
<td>21,80</td>
<td>100,00</td>
<td>0,00</td>
<td>100,00</td>
<td>0,00</td>
<td>100,00</td>
<td>0,00</td>
<td>126,51%</td>
</tr>
<tr>
<td>7 Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>20,00</td>
<td>100,00</td>
<td>0,00</td>
<td>70,98</td>
<td>21,12</td>
<td>100,00</td>
<td>0,00</td>
<td>100,00</td>
<td>0,00</td>
<td>132,29%</td>
</tr>
<tr>
<td>8 Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>71,00</td>
<td>100,00</td>
<td>0,00</td>
<td>100,00</td>
<td>0,00</td>
<td>100,00</td>
<td>0,00</td>
<td>100,00</td>
<td>0,00</td>
<td>147,73%</td>
</tr>
<tr>
<td>All Grps</td>
<td></td>
<td></td>
<td></td>
<td>1056,00</td>
<td>76,29</td>
<td>19,47</td>
<td>78,03</td>
<td>19,53</td>
<td>63,42</td>
<td>19,99</td>
<td>79,58</td>
<td>14,08</td>
<td>107,65%</td>
</tr>
</tbody>
</table>

### Comparison between the 628 branches which are inefficient in each of the three dimensions and all other 428 branches

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>628,00</td>
<td>66,14</td>
<td>14,48</td>
<td>69,01</td>
<td>16,17</td>
<td>56,19</td>
<td>13,56</td>
<td>75,56</td>
<td>11,52</td>
<td>100,00%</td>
</tr>
<tr>
<td>20 All other grps</td>
<td>N N N N 628,00 66,14 14,48 69,01 16,17 56,19 13,56 75,56 11,52 100,00%</td>
<td>22 118,95%</td>
<td>107,65%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Grps</td>
<td></td>
<td></td>
<td></td>
<td>1056,00</td>
<td>76,29</td>
<td>19,47</td>
<td>78,03</td>
<td>19,53</td>
<td>63,42</td>
<td>19,99</td>
<td>79,58</td>
<td>14,08</td>
<td>107,65%</td>
</tr>
</tbody>
</table>

Table 7. Some descriptive statistics on the different categories in the 2x2x2 matrix

*GM/FTE%: gross margin per FTE where gross margin per FTE in category 1 is equal to 100%.*
Table 8. Correlation between the efficiency perspectives and gross margin per FTE for the 628 branches in category 1 of Bank A.

<table>
<thead>
<tr>
<th>Correlations</th>
<th>N=628 (Casewise deletion of missing data)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GROSS MARGIN PER FTE</td>
</tr>
<tr>
<td></td>
<td>COMMERCIAL EFFICIENCY</td>
</tr>
<tr>
<td></td>
<td>OPERATIONAL EFFICIENCY</td>
</tr>
<tr>
<td></td>
<td>PROFITABILITY MINIMISATION</td>
</tr>
<tr>
<td></td>
<td>PROFITABILITY MAXIMISATION</td>
</tr>
<tr>
<td>GROSS MARGIN/FTE</td>
<td>100,00%</td>
</tr>
<tr>
<td>COMMERCIAL EFF.</td>
<td>55,14%</td>
</tr>
<tr>
<td>OPERATIONAL EFF.</td>
<td>40,55%</td>
</tr>
<tr>
<td>PROFITAB. MINS</td>
<td>74,79%</td>
</tr>
<tr>
<td>PROFITAB. MAX</td>
<td>51,67%</td>
</tr>
</tbody>
</table>
Figure 1. Correlation of Gross margin per FTE and profitability

Regression
95% confid.
gross margin per FTE versus profitability (Casewise MD deletion)
profitability minimisation
Correlation: $r = 0.74792$
Figure 2. Example of how branches of each district are classified in 8 categories:

- **Commercial efficient?**
  - **YE**: Operational Efficient
  - **N0**: Operational Efficient

- **Profitable**
  - **Category 2**: Branch G
  - **Category 3**: Branch A, Branch B, Branch C, Branch E, Branch F
  - **Category 6**: Branch O
  - **Category 8**: Branch S, Branch T, Branch U, Branch V, Branch W

- **Non-Profitable**
  - **Category 1**: Branch G
  - **Category 4**: Branch I, Branch J
  - **Category 5**: Branch K, Branch L, Branch M
  - **Category 7**: Branch P, Branch Q, Branch R

Commercial efficient branches are located in the upper right and lower left quadrants, while non-profitable branches are located in the upper left and lower right quadrants.