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Mergers Among German Cooperative Banks

A Panel-based Stochastic Frontier Analysis

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Abstract

Based on an unbalanced panel of all Bavarian cooperative banks for the years of 1989-97 which includes information on 283 mergers, we analyze motives and cost effects of small-scale mergers in German banking. Estimating a frontier cost function with a time-variable stochastic efficiency term we show that positive scale and scope effects from a merger arise only if the merged unit closes part of the former branch network. When we compare actual mergers to a simulation of hypothetical mergers, size effects of observed mergers turn out to be slightly more favorable than for all possible mergers. Banks taken over by others are less efficient than the average bank in the same size class, but exhibit on average the same efficiency as the acquiring firms. For the post-merger phase, our empirical results provide no evidence for efficiency gains from merging, but point instead to a leveling off of differences among the merging units.

Keywords: banking, mergers, efficiency

JEL classification: G21, L29

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1 Introduction

Between end of 1990 and 1997 more than 1,300 banks vanished from the German banking market. This decline in the number of banks at an annual rate of 4.6% is almost entirely due to mergers and acquisitions within the industry. Since Germany is still thought to be „over-banked", this tendency towards higher concentration will probably continue in the near future, albeit at a somewhat slower rate. From an industrial economics perspective, this merger wave can be considered a huge experiment concerning the trade-off between social efficiency losses and cost efficiency gains from mergers. As for the former, increasing concentration could strengthen the market power of surviving firms, resulting in higher prices for loans and services. This aspect should primarily be relevant for mergers among major banks which have begun to occur in Germany only very recently. As for the latter, large-scale production, a better mix of outputs, or enhanced management quality could lead to higher cost efficiency of merged banks. From the work of *Aiginger and Pfaffermayr (1997)* on some non-banking sectors we know that social benefits from reduced costs may easily offset social costs of higher prices and lower output levels.

In this paper we focus on the cost side of mergers among cooperative banks.[1] These banks which are typically very small and together make up about 70% of all German universal banks have been dominant in the recent merger wave. More specifically, we analyze cost effects of mergers among Bavarian cooperative banks, which represent by far the largest subgroup of the German cooperative banking sector and provide us with firm-level data on 283 mergers between 1989 and 1997. Following *Berger and Humphrey (1992)*, we distinguish between pre-merger and post-merger cost considerations. According to bank managers, size effects, i.e., economies of scale and economies of scope, constitute the most important pre-merger cost incentives for acquiring another bank. Because the magnitude of size effects depends heavily on the extent to which branch offices are closed in the post-merger phase (cf. *Shaffer, 1993*), we consider both the case of no branch closures and the case of closure of all branches of the acquired bank. Furthermore, we compare size effects from observed mergers to those of all hypothetical mergers (for a similar approach with regard to hypothetical mega-mergers see *Shaffer, 1993*, and *Altunbas et al., n.y.*). From *Berger and Humphrey (1991)* and *Lang and Welzel (1995)* we know that in banking X-inefficiency tends to be a much

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1 Our database enables us to always identify an acquiring and an acquired bank. Note, however, that there are no hostile takeovers in our data which explains why we use the term „merger".

more important source of higher costs than scale inefficiency. We therefore examine differences in the management quality between acquiring and acquired banks. If the acquiring bank is more X-efficient than the acquired bank, we interpret this difference as an incentive for merger, the reason being that additional profit can be created by transferring management skills to the acquired bank (cf. *Berger and Humphrey, 1992*). In a post-merger analysis of banking costs, we quantify the change in X-efficiency after a merger and thereby evaluate whether the transfer of better management was successful.

So far very little work has been done on bank mergers in Germany. Besides the mimeographed paper by *Altunbas et al. (n.y.)* which presents predicted size effects of hypothetical mega-mergers, there is a non-econometric analysis of ex post performance based on balance-sheets by *Tebroke (1993)*. In a paper by *Vander Vennet (1996)* performance effects of mergers and acquisitions for the whole EC region are examined. To our knowledge the present paper is the first panel-based study of bank mergers in Germany. It extends our previous empirical work on the efficiency of the German banking industry (see in particular *Lang and Welzel, 1996, 1998, Welzel and Lang, 1997*). While these papers on economies of scale and scope and on cost efficiency could provide some insights into the incentives for mergers, they did not contain any explicit analysis of mergers. It should be emphasized that a thorough ex post analysis of bank mergers imposes considerable data requirements. For the present study this problem could be overcome by building an unbalanced panel dataset consisting of seven years containing 283 mergers with an average post-merger time in the data of 4.2 years. This is considerably above the 3 years which practitioners of the banking industry often mention as the time needed for the positive cost effects of bank mergers to prevail. In addition, the panel permits the use a time-varying X-efficiency term which enables us to more accurately identify management quality at different points in time.

The plan of the paper is as follows: In section 2 we outline our specification of the banking technology as well as the implementation and measurement of X-efficiency and size efficiency. Section 3 contains a description of the data and the observed merger process. In section section 4 we present our empirical results. Section 5 sums up.

2 Methodology

The concept of a cost function lies at the analytical core of our study. Once estimated in step one of our analysis, the cost function provides us with all information needed to determine scale and scope effects of increasing bank size through merging. To allow for differences in the abilities of bank managers to control costs, we estimate a cost frontier function with a stochastic X-efficiency term capturing bank-specific distances between actual cost positions and the best-practice cost frontier. All banks in the data can be ranked relative to this frontier, holding constant all cost factors considered exogenous, such as output levels and output structure, input prices, or size of the branch network. Overall cost efficiency of a bank is then determined by its size efficiency (output levels and mixture) and by its X-efficiency. In a second step, we use this information on banking technology and X-efficiency to analyze the merger activities among cooperative banks.

$$\begin{aligned}\ln C_{kt}(w_{kt}, y_{kt}, br_{kt}, t) = {} & a_0 + \sum_{i=1}^{3} a_i \ln w_{ikt} + \sum_{m=1}^{6} b_m \ln y_{mkt} \\ & + \frac{1}{2}\sum_{i=1}^{3}\sum_{j=1}^{3} a_{ij} \ln w_{ikt} \ln w_{jkt} + \sum_{i=1}^{3}\sum_{m=1}^{6} g_{im} \ln w_{ikt} \ln y_{mkt} \\ & + \frac{1}{2}\sum_{m=1}^{6}\sum_{n=1}^{6} b_{mn} \ln y_{mkt} \ln y_{nkt} + c_0 \ln br_{kt} + \frac{1}{2} c_1 \left(\ln br_{kt}\right)^2 + \sum_{i=1}^{3} d_i \ln w_{ikt} \ln br_{kt} \\ & + \sum_{m=1}^{6} e_i \ln y_{mkt} \ln br_{kt} + f_0 t + \frac{1}{2} f_1 t^2 + \sum_{i=1}^{3} g_i \ln w_{ikt} t + \sum_{m=1}^{6} h_m \ln y_{mkt} t + u_{kt} + \nu_{kt}\end{aligned} \quad (1)$$

More specifically, consider the multi-output translog cost function presented in (1). For each bank k and time period t total costs C are assumed to depend on the vector of factor prices w, the vector of output levels y, the number of branches br, and a trend variable t (see section 3 for detailed information on the data). Technical as well as allocative X-inefficiency is captured by the inefficiency term u_{kt}, which will be discussed below. Finally, to control for measurement error and cost determinants beyond the control of management, a second random term ν_{kt} is added. The ν_{kt}'s are assumed to be i.i.d. with $\nu_{kt} \sim N\left(0, \sigma_\upsilon^2\right)$ and independent of the explaining variables.

To ensure symmetry and linear homogeneity in input prices, we impose the usual restrictions:

$$a_{ij} = a_{ji} \quad i, j = 1,2,3 \qquad b_{mn} = b_{nm} \quad m, n = 1,\ldots,6$$

$$\sum_{i=1}^{3} a_i = 1 \quad \sum_{i=1}^{3} d_i = 0 \quad \sum_{i=1}^{3} g_{im} = 0 \quad m = 1,\ldots,6 \quad \sum_{j=1}^{3} a_{ij} = 0 \quad i = 1,2,3 \quad \sum_{i=1}^{3} g_i = 0$$

As for the specification of the efficiency term u_{kt}, we follow the stochastic frontier approach originally introduced by *Aigner et. al. (1977)* and *Meeusen and van den Broeck (1977).* To ensure high flexibility and to make full use of the information in our panel, the *Battese and Coelli (1992)* model is used, which allows for time-varying Xefficiencies in an unbalanced panel. This latter aspect is particularly important in the framework of the present study because mergers clearly imply that banks disappear from the sample over time.

For a panel of length T *Battese and Coelli (1992)* define the inefficiency term as $u_{kt} = \lfloor \exp(-\eta(t-T)) \rfloor U_k$. As in most applications of stochastic frontier analysis, the positive firm effects U_k are assumed to follow a half-normal distribution, i.e., $U_k \sim |N(0,\sigma_u^2)|$. This is a special case of the approach of *Battese and Coelli* who assume u to follow the non-negative truncation of a normal distribution which, however, turned out not to be numerically robust. It is assumed that the U_k 's are independent from the regular error terms v_{kt}. Given the exponential specification of u_{kt}, X-efficiency is increasing, constant, or decreasing over time, if $\eta > 0$, $\eta = 0$, or $\eta < 0$. Note that η is assumed to be identical for all banks, leaving U_k to capture efficiency differences. We later test this restriction by estimating equation (1) for subsamples.

Figure 1:
Time-varying inefficiency and merger activity

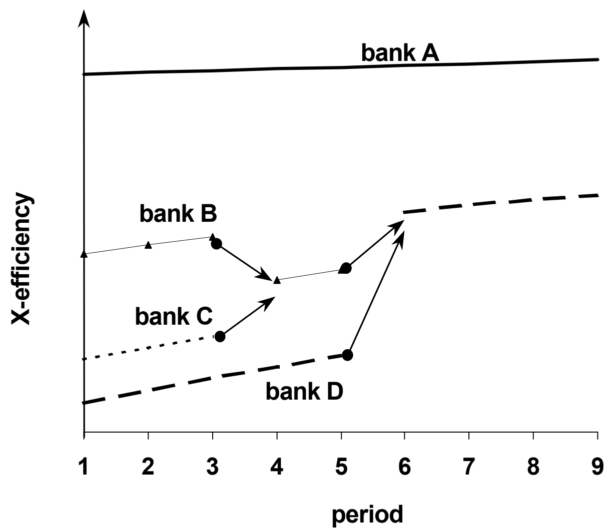


Figure 1 provides an illustration of our specification for a 9-year panel and a positive value of η leading to increased efficiency over time. In this example, only bank A can be observed for all nine years, whereas bank C is acquired by the more efficient bank B after period 3. At the end of period 5, the relatively inefficient bank D acquires unit B. Efficiency differences can therefore easily be measured as the difference in X-efficiency at the last period before a merger. To allow for X-efficiency consequences of merging, however, the merged unit has to be defined like a new entrant to the market. Furthermore, the jump to a new efficiency path has to be corrected by the trend variable η. Because of the cardinal definition of X-efficiency (for details see below), the

derivation of merger effects is more sophisticated than in *Rhoades (1993)* who defines efficiency quartiles and observes movements between them.

The log-likelihood function of our model can be expressed as (cf. *Battese and Coelli, 1992*)

$$\ln L(\beta,\sigma^2,\gamma,\eta) = -\frac{1}{2}\left[\sum_{k=1}^{K} T_k\left(\ln(2\pi)+\ln(\sigma^2)\right)\right] - \frac{1}{2}\sum_{k=1}^{K}(T_k-1)\ln(1-\gamma)$$
$$-\frac{1}{2}\sum_{k=1}^{K}\ln\left(1-\gamma-\gamma\eta_k^{'}\eta_k\right) - K\ln\left(\frac{1}{2}\right) + \sum_{k=1}^{K}\ln\left(1-\Phi\left(\frac{-\gamma\eta_k^{'}\varepsilon_k}{\sqrt{\gamma(1-\gamma)\sigma^2\left[1+\left(\eta_k^{'}\eta_k-1\right)\gamma\right]}}\right)\right) \quad (2)$$
$$+\frac{1}{2}\sum_{k=1}^{K}\left(\frac{-\gamma\eta_k^{'}\varepsilon_k}{\sqrt{\gamma(1-\gamma)\sigma^2\left[1+\left(\eta_k^{'}\eta_k-1\right)\gamma\right]}}\right)^2 - \frac{1}{2}\sum_{k=1}^{K}\frac{\varepsilon_k^{'}\varepsilon_k}{(1-\gamma)\sigma^2}$$

with $\sigma^2 = \sigma_u^2 + \sigma_\upsilon^2$, $\gamma = \sigma_u^2/\sigma^2$, $\eta_{kt} = \exp(-\eta(t-T))$, $\Phi(\cdot)$ denoting the cumulative distribution function of the standard normal, and $\varepsilon_{kt} = u_{kt} + \upsilon_{kt} = \ln C_{kt} - \beta' x_{kt}$. For the latter expression, all exogenous variables of the cost function (1) are stacked into the vector x_{kt}. T_K is the number of observations for firm *K* which may be smaller than *T*. The maximum likelihood estimation of this function generates estimates of all parameters of the frontier cost function as well as of σ^2, η and γ.

After solving the maximum likelihood problem (2), aggregate residuals ε can be derived by substituting the estimated parameter vector β into the cost function (1). *Battese and Coelli (1992)* have shown that an estimate of firm-specific efficiency is given by

$$X-EFF_{kt} = \mathrm{E}\left[\exp(-u_{kt})\middle|\varepsilon_k\right] = \frac{\Phi\left(\mu_k^*/\sigma_k^* - \eta_{kt}\sigma_k^*\right)}{\Phi\left(\mu_k^*/\sigma_k^*\right)}\exp\left(-\eta_{kt}\mu_k^* + \frac{1}{2}\eta_{kt}^2\sigma_k^{*2}\right) \quad (3)$$

with

$$\mu_\mathrm{k}^* = \frac{-\eta_k^{'}\varepsilon_k\sigma_u^2}{\sigma_\upsilon^2 + \eta_k^{'}\eta_k\sigma_u^2}$$

$$\sigma_k^{*2} = \frac{\sigma_\upsilon^2\sigma_u^2}{\sigma_\upsilon^2 + \eta_k^{'}\eta_k\sigma_u^2}$$

Because of the multiplicative relationship in our translog specification, $X-EFF_{kt}$ can be interpreted as cost ratio of a fully efficient bank to the deterministic part of the observed unit, i.e., $X-EFF_{kt} = \left(\exp(\beta' x_{kt})/\exp(\beta' x_{kt} + u_{kt})\right) \in \left]0,1\right]$. A value of one indicates a frontier firm, whereas a value of, say, 0.8 means that this particular bank could reduce its costs to a level of 80% of its actual costs.

Since due to high degrees of uncertainty the measurement of firm-specific X-efficiency levels may be problematic, we adapt the approach of *Horrace and Schmidt (1996)* to construct confidence intervals for stochastic frontier models to our unbalanced panel with time-varying firm effects. $(1-\lambda)\cdot 100\%$ confidence intervals $\left[L_{kt}, U_{kt}\right]$ for $X-EFF_{kt}\left|\varepsilon_k\right.$ are given by

$$L_{kt} = \exp\left(\eta_{kt}\left[-\mu_k^* - \sigma_k^*\Phi^{-1}\left\{\left(1-\frac{\lambda}{2}\right)\Phi\left(\frac{\mu_k^*}{\sigma_k^*}\right)\right\}\right]\right)$$
$$U_{kt} = \exp\left(\eta_{kt}\left[-\mu_k^* - \sigma_k^*\Phi^{-1}\left\{\left[1-\left(1-\frac{\lambda}{2}\right)\right]\Phi\left(\frac{\mu_k^*}{\sigma_k^*}\right)\right\}\right]\right). \tag{4}$$

μ_k^* and σ_k^* are defined as in (3). On the basis of (4), we are able to calculate upper and lower bounds for X-efficiency levels of every bank and all observation periods.

A translog cost function is non-homothetic and therefore sufficiently flexible to allow for a wide range of scale and scope effects. We isolate these size effects of mergers by comparing the aggregate costs of the individual banks to the costs of the merged unit, where we set input prices of all banks involved equal to the input prices of the acquiring firm. In detail, a size effect measure $S-EFF_{A,M}$ which considers scale as well as scope aspects is defined as

$$S-EFF_{A,M} = \frac{C\left(w^A, y^A + \sum_M y^M, br^A + \sum_M br^M, t\right) - \left[C\left(w^A, y^A, br^A, t\right) + \sum_M C\left(w^A, y^M, br^M, t\right)\right]}{C\left(w^A, y^A, br^A, t\right) + \sum_M C\left(w^A, y^M, br^M, t\right)} \tag{5}$$

Negative values of $S-EFF_{A,M}$ indicate a cost advantage of a merger of the (acquiring) bank *A* with one or more banks *M*. Note that *w* and *y* represent vectors of input prices and output quantities, respectively.

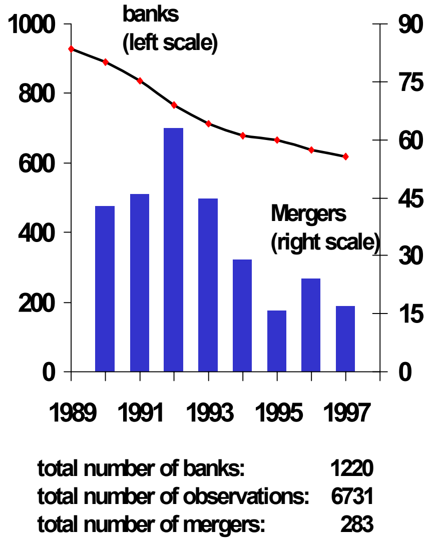
One open question concerns the treatment of the number of branches of the merged bank in the measure suggested in (5). A whole range from keeping all previous branch offices - as implicitly assumed in (5) - to closing all branch offices of the acquired bank in the case of perfect regional overlap seems possible. To separate the impact of scale and scope effects from the impact of the number of branches on our evaluation of a merger's success or failure, $S-EFF_{A,M}$ is also calculated in a second version where we reduce the branch network of the merged unit from $br^A + \sum_M br^M$ to br^A thereby assuming post-merger closure of all branches of the acquired unit.

We use this size effect measure not only to examine mergers which actually took place, but also to make predictions about hypothetical mergers. This is of particular relevance for our study of cooperative banks because these banks are subject to a principle of regional demarcation which can be expected to prevent them from picking ideal partners. In our analysis we follow *Shaffer (1993)* and *Altunbas et al. (n.y.)* and simulate all possible pairs of bank mergers. All independent banks in the year 1989 are used as empirical basis for these would-be mergers. This amounts to about 430,000 pair-wise mergers for which we calculate size effects. With regard to the definition of input prices, we assume the larger bank to be the acquiring firm.

3 Data

We apply the model specified above to the full sample of Bavarian cooperative banks which cover about 20% of all German universal banks and more than a quarter of the cooperative banking segment. Bavarian cooperative banks are of special interest because of their prominent role in the merger wave: The concentration process started earlier and has been more intense than in other segments of the German banking industry. We had access to data from all banks and all mergers of this part of the industry for the period 1989-97, allowing the construction of an unbalanced panel. Information about the number of banks and the number of mergers is presented in *Figure 2*.

Figure 2:
Number of banks and number of mergers



Because some mergers involved more than two firms, the number of banks leaving the panel exceeds the number of merger cases (305 vs. 283). The maximum number of banks participating in one single merger is four. Moreover, to allow for jumps on the efficiency paths as a consequence of merging (recall *Figure 1*), the merged unit is assumed to represent a new independent bank. As a result, the total number of firms in our data is 1,220 and therefore larger than the number of independent banks in 1989.

A closer look at the merger data in *Table 1* shows that - using 1995 prices - more than 60% of all disappearing firms had total assets between 25 and 80 million DM, i.e., were very small. Interestingly, the size of the average disappearing bank did not increase during the observation period. Acquiring banks were spread far more evenly over size classes, with a bipolar maximum density in the range of 100 to 150 and more than 350 million DM of total assets, respectively. For acquiring banks we observe a time trend with average size growing from 150 million DM in 1989 monotonously to 500 million DM in 1997. Consequently, the percentage growth because of mergers has been declining over time. Apart from a few exceptions, the acquiring bank was in terms of total assets bigger than the acquired institution.

Table 1:
Numbers of mergers by size, 1989-1997

		Total assets of disappearing institution (million DM)										
		0-25	25-40	40-60	60-80	80-100	100-150	150-200	200-250	250-350	>350	Total
Total assets of acquiring Institution (million DM)	0-25	1	0	0	1	0	0	0	0	0	0	2
	25-40	0	1	0	0	0	0	0	0	0	0	1
	40-60	1	6	2	0	0	0	0	0	0	0	9
	60-80	1	2	11	6	0	0	0	0	0	0	20
	80-100	0	7	7	6	0	0	0	0	0	0	20
	100-150	7	9	17	10	8	9	1	0	0	0	61
	150-200	1	12	11	8	2	10	2	0	0	0	46
	200-250	2	2	9	2	6	5	4	0	0	0	30
	250-350	1	6	7	7	5	9	1	2	1	0	39
	>350	0	6	11	14	7	14	13	3	5	4	77
	Total	14	51	75	54	28	47	21	5	6	4	305

Total assets in 1995 prices

Estimation of the cost function (1) is based on the full unbalanced panel, i.e., 6,731 observations for 1,220 banks. Every observation corresponds to one year. As for the definition of inputs and outputs of a banking firm, we follow the majority of the literature and use the „intermediation approach“ (cf. *Sealey and Lindley, 1977*). Within this framework, deposits are treated as inputs and loans as outputs. Total costs therefore consist of operating and interest costs, the former being defined as costs of labor and physical capital. *Table 2* gives the minimum, maximum, mean values and the standard deviations in our data.

Table 2
Description of the data, 1989-1997

Variable	Description	Mean Value	Standard-Deviation	Minimum	Maximum
	Total assets (million DM)	200.4	244.6	8.1	3761.2
C	total cost (million DM)	12.2	14.5	0.5	192.3
w_1	price of labor (thousand DM/employee)	84.8	9.9	28.1	154.9
w_2	price of capital (%)	14.6	4.9	3.3	80.4
w_3	price of deposits (%)	4.5	0.8	2.5	12.2
x_1	volume of labor (employees)	38.2	42.0	2.0	566.0
x_2	volume of physical capital (fixed assets in million DM)	4.5	5.4	0.03	69.4
x_3	volume of deposits (million DM)	179.8	215.8	7.5	3410.0
y_1	short-range loans to non-banks (million DM)	40.5	57.7	0.2	710.8
y_2	long-range loans to non-banks (million DM)	81.5	99.0	1.1	1169.0
y_3	loans to banks (million DM)	21.9	35.8	0.01	903.8
y_4	bonds, cash, real estate investments (million DM)	51.3	71.0	0.9	1817.6
y_5	commissions (million DM)	1.0	1.4	0.001	17.9
y_6	sales from commodities (million DM)	2.6	4.2	0.001	46.2
br	number of branch offices	6.0	5.4	1.0	42.0

Values in 1995-prices; mean values averaged over 1989 to 1997.

Input quantities are measured by the annual average of the number of employees, the value of fixed assets in the balance sheet, and the volume of deposits both from non-banks and banks, respectively. Factor prices for labor (w_1) and deposits (w_3) are calculated in a straightforward way by dividing expenses through input quantities. For the price of physical capital we draw upon the concept of user-costs: A price w_2 of capital is generated as sum of a bank's depreciation rate[2] and its opportunity cost. The former can be inferred from the balance sheet and the income statement. As for the latter, we use the firm-specific interest rate for loans less the expected rise in the value of the physical capital employed. We approximate this latter expectation by the growth rate of the producer price index for investment goods in Germany.

2 Depreciation without write-offs for bad loans.

The definitions of the output variables are motivated by theoretical considerations, by the institutional setup of German banking, by examples from the previous literature, and by limitations of the data we had access to. We use six outputs $y_i, i = 1,\ldots,6$: short-term loans to non-banks (y_1), long-term loans to non-banks (y_2), interbanking assets (y_3), a residual output (y_4), fees and commissions (y_5), revenues from sales of commodities (y_6). Long-term loans have a duration of at least four years. The residual output includes bonds, cash holdings and other assets not covered by loan outputs y_1 to y_3, with bonds covering more than 80% of this variable. Notice that only share holdings for portfolio purposes were included in this variable which therefore does not cover investments German banks hold in other firms. Using outputs y_5 and y_6 goes beyond the intermediation approach as commonly modeled: Income from fees and commissions is a proxy variable to capture an important feature of universal banking in the German financial sector, namely the fact that banks buy and sell shares and bonds on behalf of their customers. Revenues from selling commodities, finally, are a specific characteristic of the cooperative banks which traditionally operate in rural areas and trade in seeds etc.[3] Since about one third of the banks in our sample no longer engage in these activities, y_6 takes the value of zero for these banks which implies that the translog function is not defined. To avoid this problem, we use a substitute value of DM 1,000 in these cases. All other output variables only take strictly positive values for all banks in the panel.

4 Results

Table A-1 in the appendix contains parameter estimates from the numerical maximization of the likelihood function (2). Apart from the basic model, we also estimated some alternative specifications in order to test whether a restricted form of the error term or of the cost function could have been used. *Table A-2* presents the likelihood ratio test results for these models which clearly indicate that the complete model of the cost function with time-varying efficiency is the most appropriate. With respect to the main focus of the paper, the most important result is the strong rejection of the hypothesis that a traditional average cost function as opposed to a frontier function could adequately represent the data. Furthermore, the hypothesis that efficiency ratios are time-invariant can be rejected, too. The parameter η of the exponential function explaining u_{kt} has a

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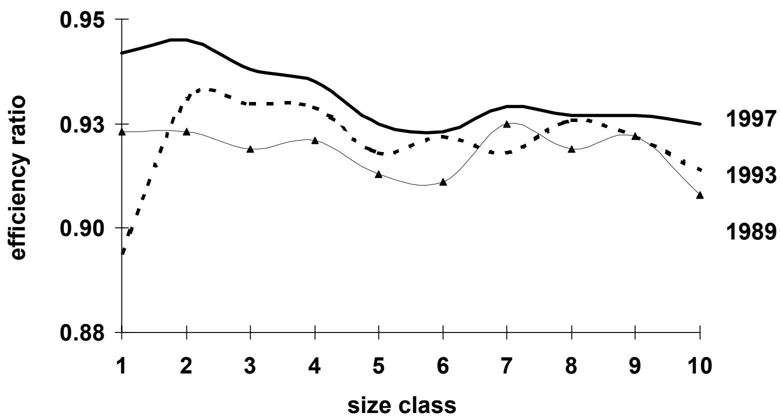
3 Variables y_5 and y_6 are the best indicators available for the services involved here. Dropping these variables would not be appropriate because on average about 18% of total income are generated from these services. For a similar approach see *Sheldon (1994)* and *Sheldon and Haegler (1993).*

positive value of 0.018, suggesting an increasing trend in bank efficiency. Splitting our sample into two subsamples - size classes 1-5 vs. size classes 6-10 - showed that smaller banks could enjoy a higher trend parameter ($\eta = 0.026$) than larger banks ($\eta = 0.00$). This difference, however, has no real consequences for the main results of our paper: The correlation of the estimated *X-EFF* values is 0.98 between the full sample and the small banks, and 0.96 between the full sample and the larger banks. We conclude that only the absolute levels of *X-EFF* are to some degree influenced by the specification of η, whereas the structure is very robust.

In a next step, efficiency scores *X-EFF* were calculated on the basis of equation (3) for all banks and the full range of observed periods. Average values of these predicted *X-EFF* for all 10 size classes are plotted against the year of observation in *Figure 3*. The definition of the size classes and some more information about the distribution of *X-EFF* is given in *Table A-3* in the Appendix.

Figure 3
X-Efficiency by size classes and years



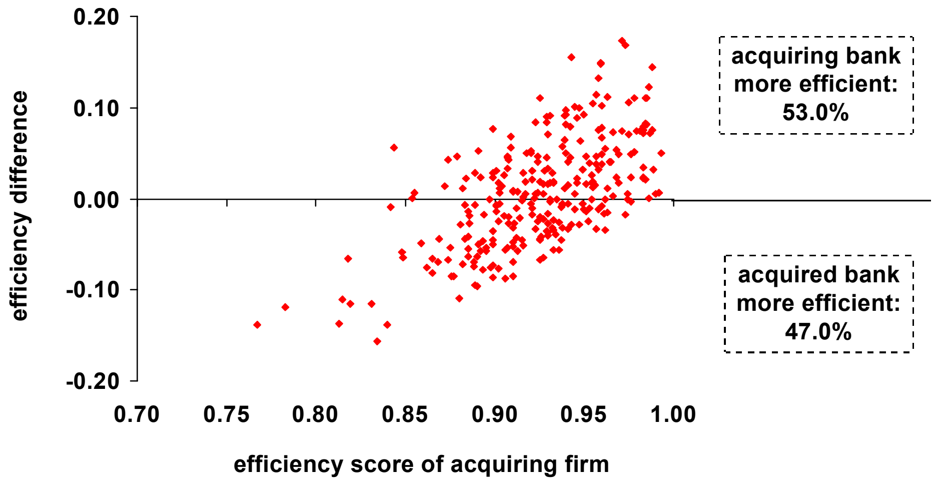
As can be seen, average X-efficiency turns out to be about 0.92 which provides us with an important benchmark: The average cooperative bank in Bavaria could reduce total costs - including expenses on deposits - by about 8.5% without any adjustments in input prices, output volumes, or the branching network.[4] At the 90%-level the difference between the upper and the lower bound of the efficiency interval is 3.5% on average which is relatively small compared to the findings of *Horrace and Schmidt (1996)*. About 89% of all banking firms show an interval width from 2% to 7%. As a

4 This result is somewhat more optimistic than previous studies for the cooperative sector (see *Lang and Welzel, 1995, 1996*), which applied other frontier approaches and were based on less observations.

consequence of the positive parameter estimate for η, efficiency scores rise slightly over time, on average from 0.918 in 1989 to 0.929 in 1997. Finally, in terms of X-efficiency larger banks are somewhat lagging behind their smaller rivals, and this difference has even been growing over the observation period.

To analyze actual mergers, we calculate the difference in X-efficiency between an acquiring and an acquired bank. In *Figure 4* these differences are plotted against the acquiring firm's efficiency score.

Figure 4
Ex ante differences in X-efficiency



Efficiency difference as X-Efficiency of acquiring bank minus (mean) X-Efficiency of acquired bank(s) for the last period before consolidation. Number of observed mergers: 283.

A positive efficiency difference could be interpreted as an indicator of an ex ante incentive for merging, because the better management quality of the acquiring bank should to some extent be transferable to the acquired bank, thereby leading to post-merger cost reductions in the merged bank (cf. *Berger and Humphrey, 1992*). It turns out, however, that such ex ante efficiency differences seem to play no major role for mergers among cooperative banks. As illustrated in *Figure 4*, in 47% of the 283 mergers the acquired bank was more X-efficient than the acquiring bank - clearly contradicting the incentive hypothesis. At the 90% confidence level in only 70 out of 283 merger cases the efficiency difference turned out to be significantly positive, i.e., the lower bound of the confidence interval of the acquiring bank was higher than the upper bound of the acquired institution. Instead, for 80 observations we observe a significant difference in favor of the acquiring bank. Note in passing that these results are compatible with anecdotal evidence: Observers of the cooperative banking sector frequently point out that there are motives like the retirement of a bank's senior management which can be as important for merger decisions as efficiency considerations.

In the next step of our analysis we calculate the size effect indicator *S-EFF* for observed as well as hypothetical mergers. Although the data indicate the existence of increasing returns to scale - the traditional (ray scale) elasticity of cost with regard to a 1% increase of all outputs is about 0.95 -, there is no guarantee that external growth through a merger will create a positive size effect: Notice the non-neutrality of the branching network with respect to costs which can be inferred from *Table A-2* in the appendix. Because German cooperative banks are mostly located in rural areas and therefore use a relatively large number of branch offices, these cost effects have to be taken into account. Furthermore, economies of scope may have a positive influence on the cost side, if the output mixes match well, but may also worsen the performance of the merged bank. Both factors can reduce or even reverse the cost gains from economies of scale. Note in passing that our measure of *S-EFF* excludes the influence of input prices (recall equation (5)).

Table 3
Size effects of observed mergers on predicted costs

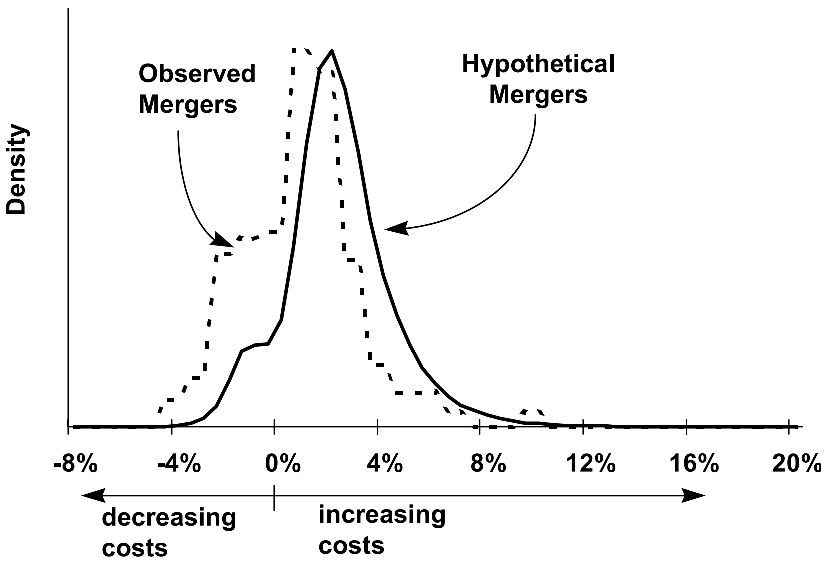
S-EFF	**Mean**	**Minimum**	**Maximum**	**Mergers with *S-EFF* < 0**
no closing of branches	0.5%	-4.4%	9.4%	38.9%
all acquired branches get closed	-2.1%	-10.2%	6.5%	84.8%

Size-effects represent scale as well as scope consequences of mergers. Number of observed mergers: 283.

Table 3 summarizes the results for observed mergers. If the acquiring bank does not close any branches of the acquired bank, the size effects of observed mergers range from cost reductions of about 4% to cost increases of 9%. On average, total costs increase by 0.5% due to a merger. Only 38.9% of all merger cases provide cost savings due to a size effect, if there are no branch closures. If we turn to the other extreme case - all branch offices of the acquired banks are closed -, we find no evidence of dramatic cost reductions due to the size effect of merging. On average there is a cost advantage of 2.1% compared to the pre-merger situation with independent banks. This cost advantage has to be considered as an upper limit for at least two reasons. First, the closure of all acquired branch offices will clearly be an exception, and second, the implicit assumption that closing branches will not reduce output levels is probably not realistic.

In the real world of cooperative banks, the acquiring bank does not enjoy absolute freedom in the selection of merger partners. First of all, only mergers between cooperative banks, but not between a cooperative bank and e.g. a savings bank are possible. Second, due to the principle of regional demarcation which is still being upheld by the head association of cooperative banks, a cooperative bank which wants to merge or acquire another cooperative bank is confined to its local or regional neighbors as partners or targets. This important restriction raises the question whether size effects from mergers would have been more favorable if others than the observed mergers had taken place. To answer this question, we calculate size effects for all hypothetical pair-wise mergers and compare the results to the actual observations.

Figure 5
Size effect distribution for observed and for hypothetical mergers



S-EFF values on abscissa; no closing of branches. Number of hypothetical mergers: 430,115; number of observed mergers: 283.

Our results are illustrated in *Figure 5* where we plot calculated *S-EFF* values for observed and hypothetical mergers against their relative frequencies. The cost changes for all hypothetical mergers cover the range from -7.1% to +20.2%. This is a much narrower and more plausible interval than the range from -56.7% to +73.0% found for mega-mergers by *Altunbas et al. (n.y.)*.[5] On average, our calculations for simulated mergers predict a cost increase of 1.9%, which is slightly more unfavorable than the value found for mergers actually observed (recall *Table 3*). Interestingly, in spite of the geographic restrictions on external growth imposed by the demarcation principle, the distribution of size effects for observed mergers is superior to the one for simulated mergers, i.e., a random match of banks produces less attractive results than the actual

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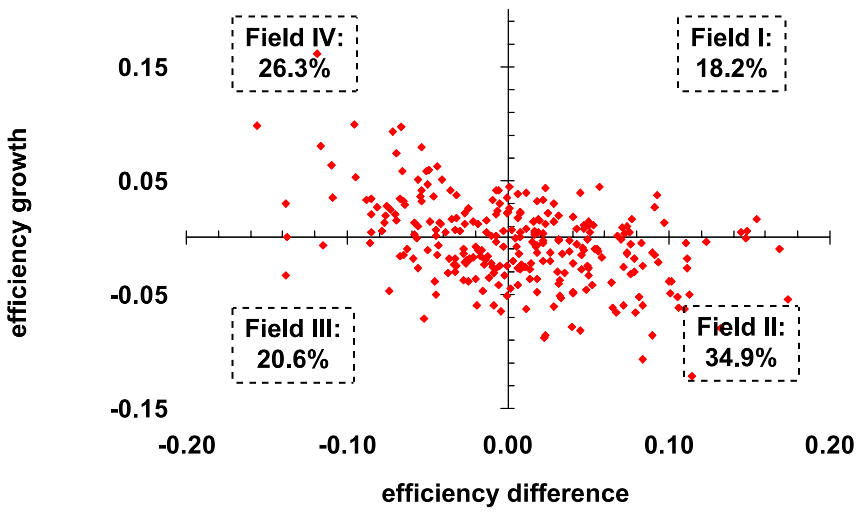
5 In their analysis *Altunbas et al. (n.y.)* find on average important cost incentives for bank mergers. Since they report extremely strong diseconomies of scale, the cost disadvantages of increased size have to be overcompensated by extremely strong economies of scope which in our view is not very plausible.

merger process. This can be concluded from comparing the densities in *Figure 5*. Note, however, that the best simulated merger is by far better than the best actual merger and that relative - as opposed to absolute - frequencies are depicted in *Figure 5*. In absolute terms the observed merger with the most favorable size effect is ranked at position 161 out of 430,115 potential mergers, the second best is ranked at 260, and so on.

Let us finally turn to the ex post performance of merged banks, i.e., the question whether there exists a positive relationship between the difference in X-efficiency before the merger and the after-merger performance. For a graphical demonstration of our results see *Figure 6*, where for all observed mergers the pre-merger difference in *X-EFF* („efficiency difference") is plotted against the change in *X-EFF* („efficiency growth"). As for the latter, we estimate the growth in X-efficiency from the acquiring bank to the merged unit. Note that a merged unit is defined as a new firm, because otherwise no jump in cost efficiency would be possible. To control for the increasing trend in X-efficiency, the observed change is corrected by the corresponding η term. After this correction, only 44.5% (the sum of field I and field IV) of the merged banks showed an outperforming improvement in *X-EFF*, whereas 55.5% enhanced their X-efficiency by less than the trend or reached even lower efficiency levels.

Figure 6
Ex post performance of mergers



Efficiency difference as X-Efficiency of acquiring unit minus (mean) X-Efficiency of acquired unit(s) for the last period before consolidation. Efficiency growth calculated as X-Efficiency of merged bank minus X-Efficiency of acquiring unit, corrected for time trend in X-Efficiency.

More interestingly, from comparing field I to field II and field IV to field III we conclude that out of the 53% share of mergers in which an X-efficiency advantage of the acquiring bank existed, just one third (18.2% vs. 34.9%) could sustain or even increase the advantage of the acquiring bank. Apparently, the transfer of superior management quality to a badly managed part of a newly merged bank does not work well or at least does not work quickly enough. If, however, the acquired bank was more X-efficient, as was the case in 47% of all mergers, outperforming efficiency growth was more frequent than underperformance or deterioration (26.3% vs. 20.6%). Taking both results together, our estimations suggest that a leveling off in efficiency differences due to mergers seems more realistic than the notion of dominance of the acquiring firm for the management quality of the merged unit.

One might suspect that this statement is too pessimistic because no adjustment period necessary for restructuring the merged unit is taken into account. For example, officials from the head organization of cooperative banks claim that a period of at least three years is needed for realization of the synergy effects. A closer look at ex post performance, however, yields no evidence to support this claim. Consider *Table 4* where we report efficiency growth results depending on the number of years since the merger had occurred. There is no sign of a positive correlation between efficiency growth and the merger date. Even those mergers which took place eight years ago do not turn out to be more successful than those with a five-year or even a two-year adjustment period.

Table 4
Efficiency effects of mergers

years since merger		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Min	-0.05	-0.17	-0.09	-0.09	-0.11	-0.12	-0.06	-0.09
efficiency growth	Mean	0.01	-0.02	-0.01	-0.00	-0.00	-0.02	-0.00	-0.00
	Max	0.16	0.05	0.10	0.10	0.06	0.09	0.06	0.10
number of cases		47	36	22	33	41	51	32	19

Efficiency growth calculated as X-Efficiency of merged bank minus X-Efficiency of acquiring unit, corrected for time trend in X-Efficiency.

5 Conclusion

In this paper we make a first attempt at analyzing the size and X-efficiency effects of observed mergers in the German banking industry. Our empirical estimations are based on data from 283 mergers among Bavarian cooperative banks during the years of 1989-97. We would like to emphasize that while cooperative banks dominated the recent merger wave in German banking, results inferred from these mergers are probably not transferable to large-scale mergers.

One of our main conclusions is that favorable size effects typically arise only if some or many branches of an acquired bank are closed in the post-merger phase. This is in line both with the reasoning of „Bayerische Vereinsbank“ and „Bayerische Hypotheken- und Wechselbank“ which due to their almost identical geographical markets decided to close branches when they merged in 1998, and with the fact that Germany is „over-banked“ in the sense of having roughly twice the number of bank branches per person than other industrialized countries (cf. *Economist, 1997, p. 69*). Comparing actual mergers to simulations of all potential mergers we find that size effects of actual mergers are slightly better than the size effects of hypothetical mergers. The principle of regional demarcation which forces cooperative banks to pick only neighboring banks as partners therefore did not impede the realization of size effects through mergers. We also conclude that pre-merger X-efficiency advantages of acquiring banks are not the main driving force behind the mergers observed. As for post-merger performance, there is no evidence for ex ante X-efficiency advantages to transform into superior performance ex post. Instead, our results point to a leveling off in efficiency differences after mergers took place. Most disappointingly, even for mergers which took place five or eight years ago no X-efficiency gains could be observed.

There clearly are quite a number of issues still open to discussion and closer examination. To name just two, let us mention first the fact that we dealt only with the cost side of bank mergers. A complete evaluation of the merger process would also have to consider the revenue side, in order to find out whether mergers increase market power (see *Lang, 1996*, with results pointing in this direction). Second, and probably more important for the relatively small banks in our sample, one could ask for the reasons of the heterogenous ex post performances which we observed.

Appendix

Table A-1:
Parameters of the Cost Function

Variable	Estimate	Standard Error	Variable	Estimate	Standard Error
σ_{υ}^{2}	0.00968	0.00061***	$0.5 \ln y_1 \ln y_5$	-0.00394	0.00516
γ	0.88172	0.00801***	$0.5 \ln y_1 \ln y_6$	0.00029	0.00053
η	0.01805	0.00451***	$0.5 \ln y_2 \ln y_2$	0.15469	0.01300***
const	1.90651	0.07212***	$0.5 \ln y_2 \ln y_3$	-0.00915	0.00311***
$\ln w_1$	0.18738	0.03944***	$0.5 \ln y_2 \ln y_4$	-0.05774	0.00617***
$\ln w_2$	0.04248	0.02861	$0.5 \ln y_2 \ln y_5$	-0.01103	0.00770
$\ln w_3$	0.77015	0.03942***	$0.5 \ln y_2 \ln y_6$	-0.00306	0.00075***
$\ln y_1$	0.19066	0.02333***	$0.5 \ln y_3 \ln y_3$	0.03066	0.00082***
$\ln y_2$	0.20641	0.03790***	$0.5 \ln y_3 \ln y_4$	-0.03380	0.00212***
$\ln y_3$	0.20700	0.01110***	$0.5 \ln y_3 \ln y_5$	0.00275	0.00252
$\ln y_4$	0.27295	0.02196***	$0.5 \ln y_3 \ln y_6$	0.00022	0.00022
$\ln y_5$	0.09575	0.01991***	$0.5 \ln y_4 \ln y_4$	0.11314	0.00427***
$\ln y_6$	0.02997	0.00299***	$0.5 \ln y_4 \ln y_5$	0.00100	0.00445
$0.5 \ln w_1 \ln w_1$	0.02446	0.01833	$0.5 \ln y_4 \ln y_6$	0.00112	0.00047**
$0.5 \ln w_1 \ln w_2$	0.01433	0.00897	$0.5 \ln y_5 \ln y_5$	0.01826	0.00276***
$0.5 \ln w_1 \ln w_3$	-0.03879	0.01694**	$0.5 \ln y_5 \ln y_6$	-0.00027	0.00055
$0.5\ln w_2 \ln w_2$	0.00774	0.00640	$0.5 \ln y_6 \ln y_6$	0.00768	0.00035***
$0.5 \ln w_2 \ln w_3$	-0.02207	0.00867**	ln br	0.04271	0.02020**
$0.5 \ln w_3 \ln w_3$	0.06087	0.01929***	0.5 ln br ln br	0.02943	0.00497***
$\ln w_1 \ln y_1$	0.00740	0.00786	ln br $\ln w_1$	-0.00225	0.00573
$\ln w_1 \ln y_2$	-0.00158	0.01082	ln br $\ln w_2$	0.00667	0.00422
$\ln w_1 \ln y_3$	0.00421	0.00376	ln br $\ln w_3$	-0.00443	0.00563
$\ln w_1 \ln y_4$	-0.00624	0.00633	ln br $\ln y_1$	0.00756	0.00403*
$\ln w_1 \ln y_5$	0.01470	0.00789*	ln br $\ln y_2$	-0.02640	0.00553***
$\ln w_1 \ln y_6$	0.00348	0.00080***	ln br $\ln y_3$	0.01232	0.00179***
$\ln w_2 \ln y_1$	0.00963	0.00510*	ln br $\ln y_4$	0.00036	0.00396
$\ln w_2 \ln y_2$	-0.01787	0.00745**	ln br $\ln y_5$	-0.00095	0.00385
$\ln w_2 \ln y_3$	-0.00141	0.00254	ln br $\ln y_6$	0.00015	0.00043
$\ln w_2 \ln y_4$	0.00768	0.00472	t	-0.13204	0.00561***
$\ln w_2 \ln y_5$	-0.00041	0.00549	0.5 t t	0.00101	0.00032***
$\ln w_2 \ln y_6$	0.00137	0.00058**	t $\ln w_1$	-0.02375	0.00156***
$\ln w_3 \ln y_1$	-0.01703	0.00784**	t $\ln w_2$	-0.00602	0.00081***
$\ln w_3 \ln y_2$	0.01945	0.01089*	t $\ln w_3$	-0.01771	0.00160**
$\ln w_3 \ln y_3$	-0.00280	0.00379	t $\ln y_1$	-0.00058	0.00076
$\ln w_3 \ln y_4$	-0.00144	0.00617	t $\ln y_2$	-0.00008	0.00109
$\ln w_3 \ln y_5$	-0.01428	0.00786*	t $\ln y_3$	-0.00146	0.00036***
$\ln w_3 \ln y_6$	-0.00485	0.00080***	t $\ln y_4$	-0.00071	0.00059
$0.5 \ln y_1 \ln y_1$	0.11927	0.00712***	t $\ln y_5$	0.00074	0.00071
$0.5 \ln y_1 \ln y_2$	-0.05855	0.00763***	t $\ln y_6$	-0.00007	0.00007
$0.5 \ln y_1 \ln y_3$	-0.01403	0.00230***			
$0.5 \ln y_1 \ln y_4$	-0.03886	0.00445***	observations	6731	

, ** or * denotes an estimate significantly different from zero at the 10%, 5% or 1% level.*
GAUSS was used for all calculations.

Table A-2
Likelihood-Ratio Tests

Null-Hypothesis	**ln L**	**Test Statistics**	**Critical Value***	**Conclusion**
Complete Model	-11714.6			
Time-invariant inefficiency ($\eta = 0$)	-11706.4	16.5	6.63	Reject H_0
No inefficieny ($\gamma = \eta = 0$)	-9404.4	4620.4	9.21	Reject H_0
No technical progress ($f_0 = f_1 = g_i = h_m = 0$, $i = 1,2,3 \quad m = 1,2,\ldots,6$)	-10899.9	1629.4	23.21	Reject H_0
No influence of branches ($c_0 = c_1 = d_i = e_m = 0$, $i = 1,2,3 \quad m = 1,2,\ldots,6$)	-11576.8	275.6	23.21	Reject H_0

* *for a 95% significance level.*

Table A-3:
X-Efficiency for Size Classes

	total assets (million DM)									
size class	1	2	3	4	5	6	7	8	9	10
total assets	0-25	25-40	40-60	60-80	80-100	100-150	150-200	200-250	250-350	>350
number of observations	102	799	1009	788	1213	746	496	600	497	481
mean	0.917	0.928	0.926	0.928	0.917	0.920	0.924	0.924	0.925	0.918
standard deviation	0.090	0.048	0.046	0.042	0.049	0.042	0.039	0.036	0.037	0.052
minimum	0.584	0.767	0.764	0.773	0.364	0.697	0.728	0.826	0.763	0.658
maximum	0.998	0.998	0.998	0.998	0.998	0.996	0.997	0.997	0.995	0.997

Total assets in 1995 prices; X-efficiency averaged over years

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