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 1989-95 which includes information on 243 mergers, we analyze motives for 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 1995 more than 1,400 banks disappeared from the German banking market. This decline in the number of banks at an annual rate of 5.3% is almost entirely due to mergers and acquisitions within the industry. Since Germany is still „over-banked“ compared to other European countries, this tendency towards increasing concentration can be expected to continue in the near future, albeit at a somewhat slower rate. From the view of industrial organization as well as from the view of anti-trust policy, the merger wave can be considered as a huge experiment which enables economists to observe the complex trade-off between social efficiency losses and cost efficiency gains. As for the former, increasing concentration tends to strengthen the market power of the surviving firms, resulting in higher prices for loans and services. This should be particularly relevant for mergers among the biggest German banks which were observed for the first time in 1997. 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. As *Aiginger and Pfaffermayr (1997)* have shown for some non-banking sectors, social benefits from reduced costs may easily offset any social costs of higher prices and lower output levels.

In this paper we focus our interest on mergers among cooperative banks.[1] These banks which together make up about 70% of all German universal banks are typically small and are the ones that dominated the merger activities during recent years. 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 data on 243 mergers between 1989 and 1995. Following *Berger and Humphrey (1992)*, we differentiate between pre-merger and post-merger cost considerations. As bank managers claim, the most important pre-merger cost incentive for acquiring another bank are size effects, i.e., economies of scale and economies of scope. Because the magnitude of size effects depends heavily on the extent to which branches are closed in the post-merger phase (cf. *Shaffer, 1993*), we simulate a range from no branch closures to 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

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1 Our dataset 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 also use the term „merger“.

that in banking X-inefficiency tends to be a much 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. Other empirical studies on German banking concentrate on the measurement of economies of scale and scope and on X-inefficiency and its components (see *Lang and Welzel, 1997a, 1997b*) and thereby provide some insights into pre-merger incentives, but do not explicitly consider mergers. It should be noted that a meaningful 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 which should be enough time for merged units to adjust to the new situation. Furthermore, a time-varying X-efficiency term can be implemented, 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 necessary 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 frontier cost function using a stochastic X-efficiency term which measures the bank specific distances from their actual cost positions to the best-practice cost frontier. All firms can be ranked relative to this frontier, holding constant all exogenous determinants of banking costs such as output levels and output structure, input prices, or size of the branch network. The overall cost efficiency of a banking firm 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.

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

To begin with the first step of our analysis, 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 represented by the efficiency variable u. Finally, to control for measurement error and cost determinants beyond the control of management, a random term ν with the usual properties is added.

To ensure symmetry and linear homogeneity in input prices, we impose the following 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).* To ensure high flexibility and to make full use of the given information, the *Battese and Coelli (1992)* model is used, which allows time-varying X-efficiencies for unbalanced panel data.[2] This latter aspect

2 One of the main advantages of a panel is the more accurate prediction of X-efficiency u_{kt} as the number of periods is growing. A greater number of observations in a pure cross-sectional sample does not necessarily reduce the standard error of estimated X-efficiency (cf. *Greene, 1993*).

is particularly important in the framework of this paper because the merger activities over time make a lot of banks disappear from the sample.

Battese and Coelli define the time varying X-efficiency term u_{kt} for a given panel length of T periods by $u_{kt} = \lfloor \exp(-\eta(t-T)) \rfloor U_k$. As in most applications of stochastic frontier analysis, the positive firm effects U_k are assumed to follow a half-normal distribution, i.e., $U_k \sim |N(0, \sigma_u^2)|$.[3] 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.

Figure 1:
Time-varying inefficiency and merger activity

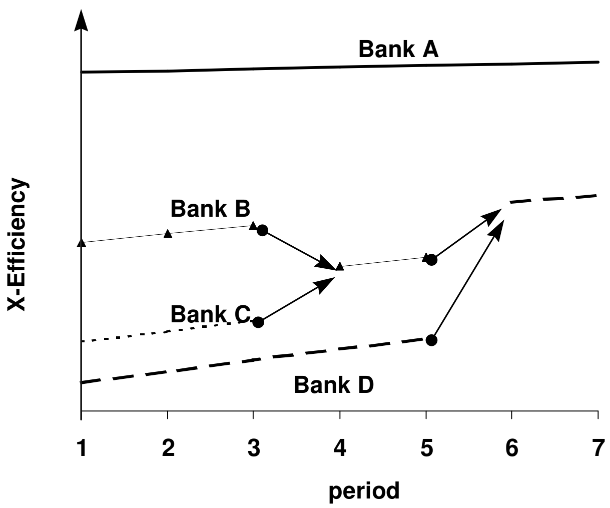


Figure 1 provides an illustration of this specification for a 7-year panel and a positive value of η which forces efficiency levels to increase over time. In this example, only Bank A can be observed for all seven years, whereas bank C is acquired by the more efficient Bank B after period 3. At the end of period 5, the relative 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 be-

[3] This is actually a slight modification 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.

low), 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*)

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

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 the following formula can be used to get an estimate of firm specific efficiency:

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

with

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

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

Because of the multiplicative relationship in a translog cost function, $X-EFF_{kt}$ can be interpreted as cost ratio of a fully efficient bank to the deterministic part of the observed unit, i.e., $X-EFF_{kt} = \left(\exp(\beta' x_{kt})/\exp(\beta' x_{kt} + u_{kt})\right) \in \rfloor 0,1 \rfloor$. 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.

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 consequences is constructed as

$$S-EFF_{A,M} = \frac{C\left(w^A, y^A + \sum_M y^M, br^A + \sum_M br^M, t\right) - \left[C\left(w^A, y^A, br^A, t\right) + \sum_M C\left(w^A, y^M, br^M, t\right)\right]}{C\left(w^A, y^A, br^A, t\right) + \sum_M C\left(w^A, y^M, br^M, t\right)} \quad (4)$$

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 as *y* represents a vector of input prices and output quantities, respectively.

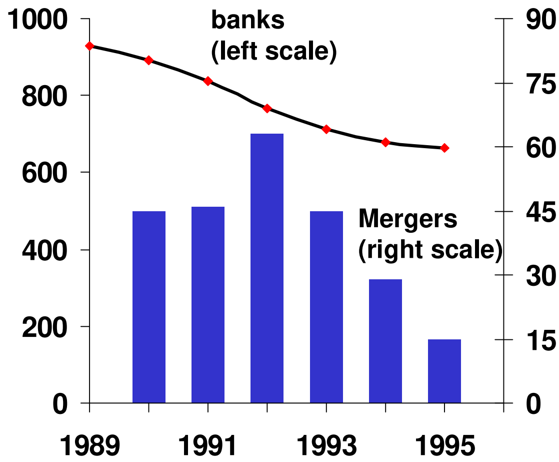
One open question concerns the treatment of the number of branches of the merged bank in the measure suggested in (4). A whole range from keeping all previous branch offices - as implicitly assumed in (4) - to closing all branch offices of the acquired bank in the case of perfect regional overlap seems 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 the size effect measure not only to examine mergers which actually happened 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 1989-95, allowing the construction of an unbalanced panel. Information about the number of banks and the number of mergers is presented in *Figure 2*.[4] Because of some mergers involving more than two firms, the number of disappearing banks exceeds the number of merger cases (265 vs 243). 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 dataset is 1,179 and therefore larger than the number of independent banks in 1989.

Figure 2:
Number of banks and number of mergers



total number of banks:	**1179**
total number of observations:	**5477**
total number of mergers:	**243**

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 banks. 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 maximum density in the range of 100 to 150 million DM of total assets. For acquiring banks we observe a time trend with average size growing from 150 million DM in 1989 monotonously to 250 million DM in 1995. Consequently, the per-

4 Information on the distribution of observations over size classes can be found in the Appendix.

centage growth because of mergers has been declining over time. Apart from a few exceptions, the acquiring bank was - measured in terms of total assets - bigger than the acquired institution.

Table 1:
Numbers of mergers by size, 1989-1995

		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
	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
Total assets	60-80	1	2	11	6	0	0	0	0	0	0	20
of acquiring	80-100	0	7	7	6	0	0	0	0	0	0	20
institution	100-150	6	8	17	10	8	9	1	0	0	0	59
(million	150-200	1	12	9	7	2	10	2	0	0	0	43
DM)	200-250	1	2	8	1	5	4	4	0	0	0	25
	250-350	1	6	7	6	5	8	1	1	1	0	36
	>350	0	5	8	8	6	8	8	2	2	3	50
	Total	12	49	69	45	26	39	16	3	3	3	265

Total assets in 1995 prices

The estimation of the cost function (1) is based on information of the complete unbalanced panel, i.e., is 5,477 observations for 1,179 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 rely on 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 dataset.

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 nonbanks 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[5] 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

5 Depreciation without write-offs for bad loans.

physical capital employed. We approximate this latter expectation by the growth rate of the producer price index for investment goods in Germany.

Table 2
Description of the data, 1989-1995

Variable	Description	Mean Value	Standard-Deviation	Minimum	Maximum
	total assets (million DM)	184.3	226.7	8.1	3139.0
C	total cost (million DM)	11.7	14.3	0.5	192.3
w_1	price of labor (thousand DM/employee)	83.6	9.8	28.1	154.9
w_2	price of capital (%)	14.6	5.0	3.3	80.4
w_3	price of deposits (%)	4.7	0.8	2.5	12.2
x_1	volume of labor (employees)	36.4	40.7	2.0	566.0
x_2	volume of physical capital (fixed assets in million DM)	4.3	5.0	0.02	57.7
x_3	volume of deposits (million DM)	166.8	202.6	13.3	2480.0
y_1	short-range loans to non-banks (million DM)	37.8	55.5	0.2	694.5
y_2	long-range loans to non-banks (million DM)	72.9	88.8	1.1	991.8
y_3	loans to banks (million DM)	21.2	35.0	0.01	903.8
y_4	bonds, cash, real estate investments (million DM)	47.4	64.9	0.9	1496.8
y_5	commissions (million DM)	0.9	1.3	0.001	17.3
y_6	sales from commodities (million DM)	2.6	4.2	0.001	46.2
br	number of branch offices	5.9	5.3	1.0	42.0

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

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. In particular we consider 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.[6] 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 dataset.

4 Results

Table A-1 in the Abstract contains parameter estimates from the numerical maximization of the likelihood function (2).[7] 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, clearly indicating 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} takes a positive value, suggesting an increasing trend in bank efficiency.

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. 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 branch-

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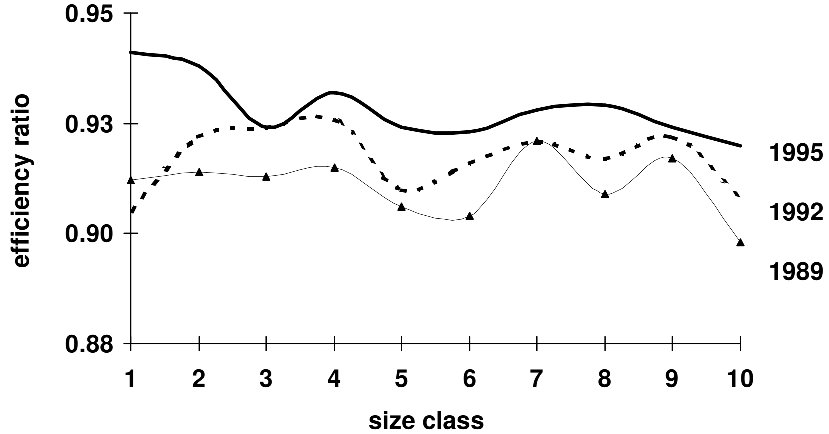
6 Variables y_5 and y_6 are the best indicators available for the services involved here. Dropping these variables would not be appropriate because on average about 18% of total income are generated from these services. For a similar approach see *Sheldon (1994)* and *Sheldon and Haegler (1993).*

7 All calculations were run on GAUSS.

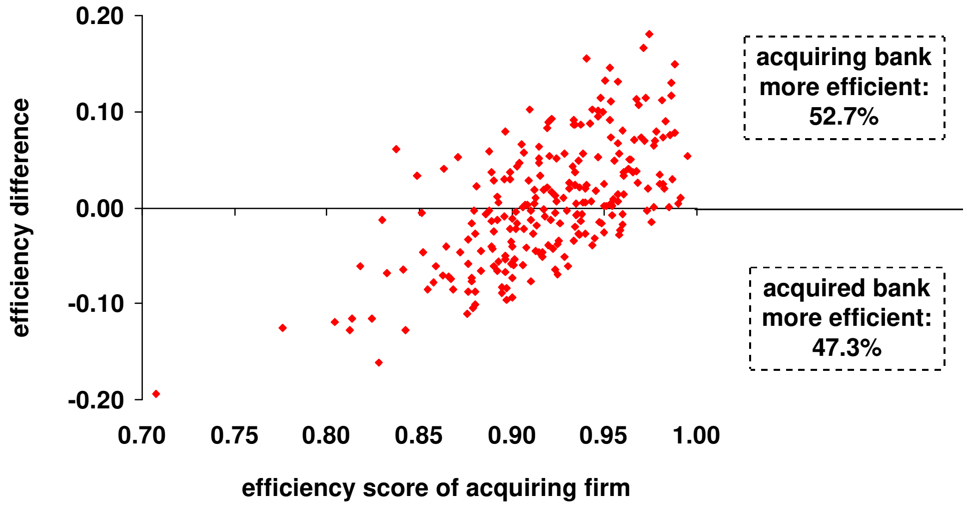
ing network.[8] As a consequence of the positive parameter estimate for η, efficiency scores rise over time, on average from 0.911 in 1989 to 0.926 in 1995. Finally, in terms of X-efficiency larger banks are somewhat lagging behind their smaller rivals, with this difference even growing over the observation period.

Figure 3
X-Efficiency by size classes and years



To analyze actual mergers, we calculate the difference in X-efficiency between an acquiring and an acquired bank and plot them in *Figure 4* 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: 243.

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8 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 a smaller dataset.

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 firm should to some extent be transferable to the acquired firm, 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 about 47% of the 243 mergers the acquired bank was more X-efficient than the acquiring bank. What we see instead looks more like a random process combined with a tendency for more efficient acquiring banks being involved in mergers where they enjoy an efficiency advantage and vice versa.

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 of scale - the traditional (ray scale) elasticity of cost with regard to an 1%-increase of all outputs is about 0.95 -, there is no automatism between the external growth of a bank and a positive size effect of such a merger project. The first reason for this presumption is the non-neutrality of the branching network with respect to costs which can be clearly 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. The second point to mention are economies of scope, which 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 determinants 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 (4)).

Table 3
Size-effects of observed mergers on predicted costs

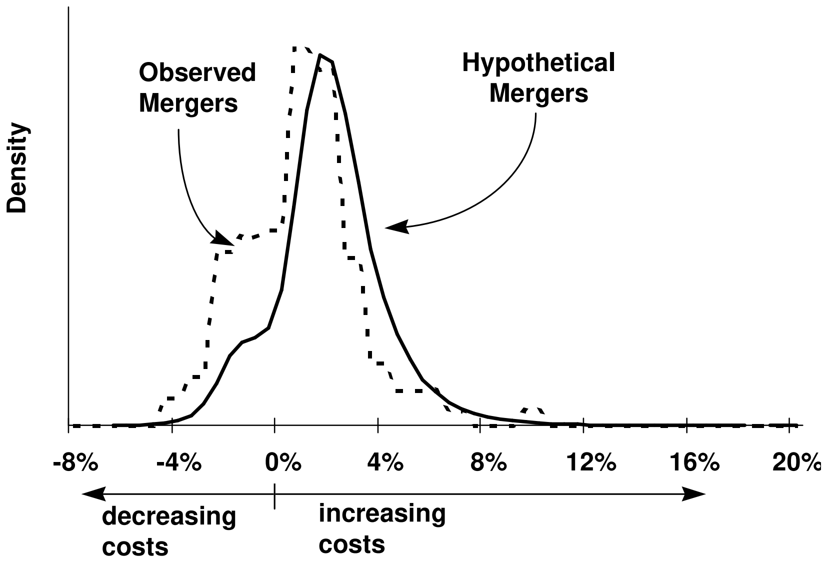
S-EFF	**Mean**	**Minimum**	**Maximum**	**Mergers with *S-EFF* < 0**
no closing of branches	0.5%	-4.4%	9.9%	37.4%
all acquired branches get closed	-2.4%	-10.1%	5.2%	88.1%

Size-effects represent scale as well as scope consequences of mergers. Number of observed mergers: 243.

Table 3 summarizes the results for observed mergers. If the acquiring bank does not close any branches of the target bank, the size-effects of observed mergers range from cost reductions of about 4% to cost increases of 10%. On average, total costs increase by 0.5% due to a merger. Only 37.4% 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 2.4% 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, because 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. Due to the principle of 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.[9] 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 pairwise 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: 243.

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

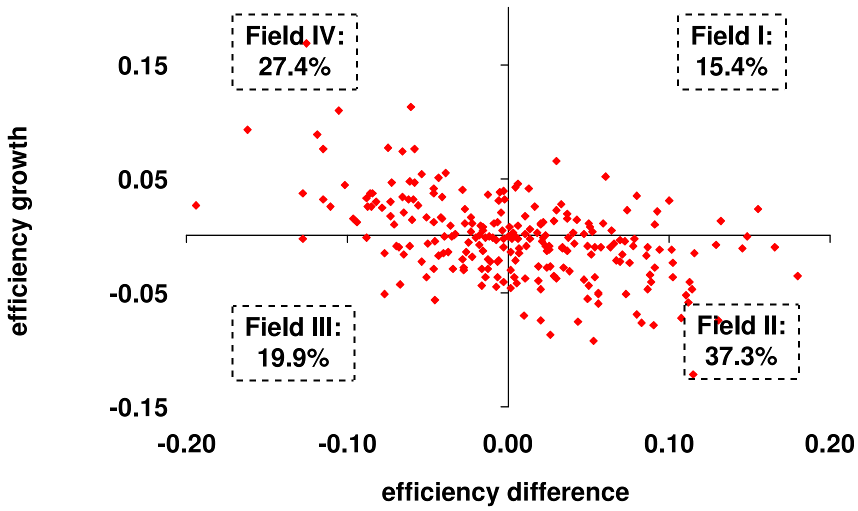
9 We know of no case where a cooperative bank acquires a bank which is not a cooperative bank.

all hypothetical mergers cover the range from -7.9% to +19.9%. 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.).*[10] On average, our calculations for simulated mergers predict a cost increase of 1.6%, 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 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 number 548 out of 430,115 potential mergers, the second best is ranked at 661, 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 in a one-year comparison. 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 42.8% (the sum of field I and field IV) of the merged banks showed an outperforming improvement in *X-EFF*, whereas 57.2% enhanced their X-efficiency by less than the trend or reached even lower efficiency levels.

10 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 is not very plausible.

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 in the first period after the merger minus X-Efficiency of acquiring unit for the last period before consolidation. Number of observations: 243.

More interestingly, from comparing field I to field II and field IV to field III we conclude that out of the 52.7% share of mergers in which an X-efficiency advantage of the acquiring bank existed, less than one third (15.4% vs 37.3%) 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. If, however, the acquired bank was more X-efficient, as was the case in 47.3% of all mergers, outperforming efficiency growth was more frequent than underperformance or deterioration (27.4% vs 19.9%). 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.

5 Conclusion

In this paper we made a first attempt at analyzing the size and X-efficiency effects of observed mergers in the German banking industry. We could base our empirical estimations on data from 243 mergers among Bavarian cooperative banks during the years of 1989-95. 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 the kind of mega-mergers in the offing.

One of our main conclusions is that favorable size effects typically arise only if some or many branches of an acquired banks are closed in the post-merger phase. This is in line both with the reasoning of „Bayerische Vereinsbank“ and „Bayerische Hypotheken- und Wechselbank“ which serve an almost identical geographical market and announced a merger in July 1997 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 driving force behind the mergers observed. As for post-merger performance, we find 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.

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, one could ask whether a merged bank needs a longer period of adjustment than the one presumed in our analysis of post-merger efficiency.

Appendix

Table A-1:
Parameters of the Cost Function

Variable	Estimate	Standard-Error	Variable	Estimate	Standard-Error
σ_{υ}^{2}	0.01020	0.00063***	0.5 ln y_1 ln y_5	-0.00633	0.00570
γ	0.88588	0.00772***	0.5 ln y_1 ln y_6	-0.00090	0.00064
η	0.03315	0.00566***	0.5 ln y_2 ln y_2	0.10943	0.01542***
const	1.85347	0.10499***	0.5 ln y_2 ln y_3	-0.00313	0.00367
ln w_1	0.28374	0.04987***	0.5 ln y_2 ln y_4	-0.04288	0.00736***
ln w_2	0.02845	0.03506	0.5 ln y_2 ln y_5	-0.01108	0.00885
ln w_3	0.68780	0.05867***	0.5 ln y_2 ln y_6	-0.00211	0.00090**
ln y_1	0.15832	0.02624***	0.5 ln y_3 ln y_3	0.03056	0.00094***
ln y_2	0.27306	0.04579***	0.5 ln y_3 ln y_4	-0.03773	0.00252***
ln y_3	0.20885	0.01434***	0.5 ln y_3 ln y_5	0.00324	0.00300
ln y_4	0.27385	0.02681***	0.5 ln y_3 ln y_6	0.00011	0.00028
ln y_5	0.08778	0.02684***	0.5 ln y_4 ln y_4	0.10508	0.00491***
ln y_6	0.03219	0.00345***	0.5 ln y_4 ln y_5	0.00342	0.00517
0.5 ln w_1 ln w_1	-0.02383	0.02341	0.5 ln y_4 ln y_6	0.00104	0.00057*
0.5 ln w_1 ln w_2	0.00551	0.01082	0.5 ln y_5 ln y_5	0.01925	0.00308***
0.5 ln w_1 ln w_3	0.01833	0.02059	0.5 ln y_5 ln y_6	0.00016	0.00063
0.5ln w_2 ln w_2	0.00869	0.00704	0.5 ln y_6 ln y_6	0.00823	0.00040***
0.5 ln w_2 ln w_3	-0.01420	0.01075	ln br	0.03448	0.02386
0.5 ln w_3 ln w_3	-0.00413	0.02208	0.5 ln br ln br	0.02910	0.00591***
ln w_1 ln y_1	0.02159	0.00974**	ln br ln w_1	-0.00400	0.00685
ln w_1 ln y_2	-0.04447	0.01232***	ln br ln w_2	0.01068	0.00477**
ln w_1 ln y_3	0.01048	0.00438**	ln br ln w_3	-0.00668	0.00683
ln w_1 ln y_4	0.00195	0.00797	ln br ln y_1	0.00656	0.00469
ln w_1 ln y_5	0.02789	0.01009***	ln br ln y_2	-0.02396	0.00682***
ln w_1 ln y_6	0.00330	0.00095***	ln br ln y_3	0.01379	0.00211***
ln w_2 ln y_1	0.00947	0.00579	ln br ln y_4	0.00036	0.00458
ln w_2 ln y_2	-0.00768	0.00969	ln br ln y_5	-0.00119	0.00451
ln w_2 ln y_3	-0.00365	0.00295	ln br ln y_6	-0.00041	0.00051
ln w_2 ln y_4	0.00048	0.00545	t	-0.02715	0.00554***
ln w_2 ln y_5	-0.00454	0.00669	0.5 t t	0.00966	0.00051***
ln w_2 ln y_6	0.00147	0.00067**	t ln w_1	-0.00053	0.00192
ln w_3 ln y_1	-0.03106	0.00940***	t ln w_2	-0.00426	0.00109***
ln w_3 lny $_2$	0.05216	0.01331***	t ln w_3	0.00479	0.00194**
ln w_3 ln y_3	-0.00682	0.00443	t ln y_1	-0.00085	0.00100
ln w_3 ln y_4	-0.00243	0.00776	t ln y_2	-0.00423	0.00145***
ln w_3 ln y_5	-0.02336	0.01173**	t ln y_3	-0.00037	0.00047
ln w_3 ln y_6	-0.00477	0.00097***	t ln y_4	0.00183	0.00078**
0.5 ln y_1 ln y_1	0.11605	0.00829***	t ln y_5	0.00206	0.00094**
0.5 ln y_1 ln y_2	-0.03986	0.00904***	t ln y_6	0.00026	0.00010***
0.5 ln y_1 ln y_3	-0.01970	0.00269***			
0.5 ln y_1 ln y_4	-0.04608	0.00515***	observations	5477	

Table A-2
Likelihood-Ratio Tests

Null-Hypothesis	**ln L**	**Test Statistics**	**Critical Value**	**Conclusion**
Complete Model	-9260.5			
Time-invariant inefficiency ($\eta = 0$)	-9234.5	52.0	6.63	Reject H_0
No inefficieny ($\gamma = \eta = 0$)	-7621.9	3277.2	9.21	Reject H_0
No technical progress ($f_0 = f_1 = g_i = h_m = 0$, $i = 1,2,3 \quad m = 1,2,\ldots,6$)	-8515.8	1489.4	23.21	Reject H_0
No influence of branches ($c_0 = c_1 = d_i = e_m = 0$, $i = 1,2,3 \quad m = 1,2,\ldots,6$)	-8975.1	570.8	23.21	Reject H_0

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	98	722	879	668	1012	588	382	455	361	312
mean	0.908	0.919	0.921	0.923	0.912	0.917	0.921	0.919	0.920	0.910
standard deviation	0.090	0.051	0.048	0.045	0.052	0.045	0.038	0.038	0.041	0.061
minimum	0.575	0.725	0.733	0.758	0.354	0.682	0.800	0.798	0.699	0.602
maximum	0.997	0.998	0.998	0.997	0.997	0.997	0.998	0.998	0.997	0.997

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

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