Thünen-Series of Applied Economic Theory

Thünen-Reihe Angewandter Volkswirtschaftstheorie

Working Paper No. 111

The Impact of Regional and Demographic Factors on the Efficiency of German Savings Banks

by

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2009

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November 16, 2009

Abstract

This paper examines the influence of environmental factors on technical, cost, scale and revenue efficiency of German savings banks in 2001-2005. Taking into account growing regional disparities in economic wealth and population size, it differentiates between declining and growing regions. Regional and demographic factors explain part of the variation in efficiency levels. Population density and branch penetration positively affect efficiency in growing regions. A negative impact of economic power and a positive impact of competitive pressure on efficiency support the quiet life hypothesis. In declining regions, a larger share of elder people reduces bank efficiency. Savings banks seem to be well adapted to unfavorable environmental conditions.

JEL classifications: G21, D21, D24, R1

Key words: savings banks, efficiency, Data Envelopment Analysis, demographic change, regional disparities

[*] This paper is based on the research project “Der Einfuss regionaler und demographischer Umfeldfaktoren auf die Kosten- und Ertragssituation von Sparkassen”, financed by the Wissenschaftsförderung der Sparkassen-Finanzgruppe e.V., Bonn. We are grateful for this support.

1. Introduction

In all countries, population and wealth are unevenly distributed across regions. In Germany, there is a gap between rich, agglomerated regions concentrated in the south-west and underdeveloped, peripheral regions concentrated in the north-east. While population is aging in all regions, due to declining fertility rates and increasing longevity, migration of young people from poor, peripheral regions to rich, agglomerated regions increases the disparities in regional wealth and population age. On the one hand, there are 'declining regions', losing population and economic wealth and growing old relatively quickly. On the other hand, there are 'growing regions', gaining population and economic wealth and getting older more slowly. From 2002 to 2020, about 227 out of the 439 districts and independent cities in Germany will face a declining population with above average speed of aging (BBR 2006).

This demographic change is a huge challenge for financial institutions, in particular for savings banks and other regional banks. As decentralized financial institutions bound to the regional principle they cannot diversify regional risks or retreat from declining regions. Changes in the size and structure of the population in their local market directly affect volume and structure of the demand for retail banking services. Therefore, we expect that regional and demographic environmental factors are important determinants of the profitability, efficiency and competitiveness of public savings banks. Apart from the regional principle, public savings banks in Germany have the mission to foster the economic development within their business area, thus contributing to the public goal of equal living standards in all regions. Therefore, understanding regional and demographic developments and their consequences is of particular importance for them. Within the three-pillar commercial banking system of Germany, composed of private banks, public savings banks and cooperative banks, the public savings banks are the largest pillar. In March 2008, savings banks accounted for 34%, private banks for 30% and cooperative banks for 12% of total banking assets (Deutsche Bundesbank, 2008, p. 24).[1] In the retail banking segment, the savings banks play an even larger role.

[1] The savings banks pillar comprises 444 municipal savings banks and 12 Landesbanken, the private bank pillar comprises five big banks (Deutsche Bank AG, Dresdner Bank AG, Hypovereinsbank AG, Commerzbank AG, Deutsche Postbank AG), branches of foreign banks, regional and other banks, and the cooperative bank pillar comprises 1232 local cooperative banks and two central institutions. The remaining banks are special commercial banks.

Previous evidence shows that regional and demographic factors have a significant influence on the business, profitability and branch penetration of German savings banks (Conrad and Neuberger, 2008; Conrad et al., 2009). Recent international literature on the efficiency of financial institutions has focused on the role of environmental factors in explaining variations in efficiency. For German savings banks, this issue has been tackled only by Bresler (2007) so far, whose results are restricted by a narrow data set and measurement of efficiency (X-efficiency). The present paper goes beyond previous literature by examining the impact of regional and demographic factors on the efficiency of German savings banks using a wide range of efficiency measures and differentiating between declining and growing regions.

The paper is organized in five more sections. Section 2 provides an overview of the literature and the expected relationships. Section 3 informs about the methodology, and Section 4 about the data and variables used in this study. The results are presented and discussed in Section 5. Section 6 concludes.

2. Literature review and expected relationships

2.1 Influence of environmental factors on bank efficiency

Research about effects of the environment on bank efficiency has begun not before this millennium. The first studies compare bank efficiency across nations (Dietsch and Lozano-Vivas, 2000; Chaffai et al., 2001), while the more recent ones investigate the determinants of bank efficiency on the regional level within single countries (Wutz, 2002; Bos and Kool, 2006; Hahn, 2005; Drake et al., 2006; Chaffai and Dietsch, 2007; Bresler, 2007).

Chaffai and Dietsch (2007) examine the role of the environment for profit efficiency of bank branches pertaining to a large banking group in France, using a cluster analysis to define regions according to differences in economic wealth and socio-economic factors. Bank branches in rural regions show the highest efficiency levels, while those in small cities with high unemployment or in centers of large cities tend to be the most inefficient. For the latter in particular, the variation in efficiency can be explained to a large part by environmental factors. The results are consistent with those of a previous comparison of bank efficiency across France, Germany, Italy and Spain (Chaffai et al. 2001). The best environment for bank efficiency, characterized by high population density, per capita income and access to finance was found for Germany. Bos and Kool (2006) investigate the influence of banks' strategic choices, local banking market conditions, and regional macro variables on cost and profit efficiency of cooperative local banks in the Netherlands. They find that the impact of these environmental factors is significant, but can explain only 10% of the variation in cost and profit efficiency (Bos and Kool, 2006). A larger impact of the environment on bank efficiency has been found by Hahn (2005) for Austrian banks. Regional economic power, population density and level of economic development show significant positive effects on technical efficiency. However, the effects differ between banking groups, with the efficiency of (private) savings banks being the least affected by environmental factors.

Wutz (2002) and Bresler (2007) show that the efficiency of regional banks in Germany depends on the environment. Wutz (2002) uses a (non-parametric) Data Envelopment Analysis (DEA) to measure technical efficiency of Bavarian cooperative banks in a first step. In a second step, he examines the influence of the size of the business area, market penetration, customer structure, deposit volume per customer, market share and gross interest rate spread on efficiency levels. Only deposit volume per customer and gross interest rate spread show a significant and positive impact. A higher deposit volume per customer may indicate a better economic environment, which contributes to higher efficiency. A higher interest rate spread may indicate lower competition. Thus, cooperative banks in markets with high competitive pressure (low interest rate spread) seem to be less efficient.

Bresler (2007) uses a one-step (parametric) approach to measure the efficiency of German savings banks. She differentiates between location-specific factors (size and economic power of business area, intensity of competition, market penetration) and bank-specific external factors (equity capital and size) as possible determinants of efficiency. Since savings banks cannot increase their equity capital and size, at least not in the short run, these bank-specific factors are considered exogenous. The equity capital ratio (equity capital per assets) shows a significant positive influence, and bank size a significant negative influence on the efficiency of savings banks. Due to missing data, only one location-specific factor, economic power (measured by income per capita), is included in the regressions. Its influence on efficiency is significant, but close to zero.

All in all, these studies show that environmental factors are relevant for the efficiency of financial institutions and should therefore be included in further work. The weak relationship between external factors and bank efficiency found in some studies may be due to problems of variable measurement or missing data.

2.2 Expected relationships

We expect that environmental factors have a significant impact on the efficiency of public savings banks in Germany, measured by technical, cost and profit efficiency. As shown by Wengler (2006), Conrad and Neuberger (2008), Conrad et al. (2009) and Gärtner (2008), the business and profitability of German savings banks clearly depend on regional and demographic factors. Conrad and Neuberger (2008) identified the following key factors influencing branch penetration, volume of deposits, volume of loans, and profitability:

- Demographic factors: population density (number of inhabitants per km²), share of elder people (percent of inhabitants aged 75 or more), location in a declining vs. growing region.
- Regional economic factors: economic wealth (purchasing power per capita), intensity of competition (number of competitor branches per savings bank branches), location in East vs. West Germany.
- Bank-specific factors: bank size (average volume of savings bank assets per capita), equity capital.

Population density showed a positive influence on branch penetration, deposit volume and loan volume. We expect that its influence on efficiency has the same sign. Population density affects the degree of capacity utilization, production cost and possibilities to reap profits (Dietsch and Lozano-Vivas, 2000; Chaffai et al., 2001; Lozano-Vivas et al., 2002). With a larger number of inhabitants per branch, gains from economies of scale and specialization can be achieved. Moreover, the costs of distributing financial services are lower in more densely populated regions than in peripheral ones, because more inhabitants are reached with a given number of branches. There is more scope for financial intermediation which is likely to increase profits. Therefore, we expect that technical, cost and profit efficiency levels are higher at savings banks in densely populated regions than at those in peripheral regions.

Also economic wealth is expected to affect bank efficiency positively. In regions with higher purchasing power per capita, demand for financial services is higher, which is likely to increase technical, cost and profit efficiency (Chaffai et al., 2001; Bresler, 2007). With higher demand, indivisible production factors are better utilized, lowering average costs. Higher economic power also raises opportunities to reap profits and helps to compensate inefficiencies caused by internal factors (Wutz 2002).

The expected influence of competition (low market concentration or market shares) on technical, cost and profit efficiency is ambiguous (Dietsch and Lozano-Vivas, 2000; Wutz, 2002). It is positive, if a high market concentration or market share of a single bank reduces the incentives of this bank to use resources efficiently or maximize profits (so-called market structure hypothesis or quiet life hypothesis).[2] It is negative, if a high market share is the result of a cost reducing management or production technology (so-called efficiency-structure hypothesis).

In regions with a larger share of elder people bank efficiency levels are likely to be lower. Elder people tend to have lower demand for financial services, but higher demand for costly personal advice in bank branches than younger people. They are less inclined to use cost-saving innovative distribution channels. Thus, we expect a negative influence of the share of elder people on technical, cost and profit efficiency.

Moreover, we expect that efficiency is lower for saving banks in declining regions and East Germany compared to growing regions and West Germany, due to less favorable economic and demographic conditions.

As a bank-specific factor, bank size has been shown to be relevant for the efficiency of German savings banks (Conrad and Neuberger, 2008; Bresler, 2007). Because of the regional principle, public savings banks cannot grow through geographic expansion, but only through gaining market shares in their local market. The influence of bank size on efficiency is ambiguous. On the one hand, it may be positive because larger banks can reap economies of scale and scope or gains from diversification. On the other hand, it may be negative because of decreasing returns to scale if the bank exceeds optimal size, higher X-inefficiencies in larger companies,[3] or lower incentives to use resources efficiently because insolvency or takeover risks are lower (Bresler, 2007). Bresler finds that small savings banks are more efficient than larger ones. Also bank equity capital might be relevant for efficiency. Conrad and Neuberger (2008) and Bresler (2007) found a positive influence of equity capital on the number of loans and profitability of German savings banks. Banks with higher equity capital

[2] See Hicks (1935). For evidence on the quiet life hypothesis from German savings banks see Koetter and Vins (2008).

[3] For the concept of X-inefficiency see Leibenstein (1966).

are likely to be more efficient, because they can extend more loans, reducing average costs and increasing profits.

Further environmental factors may be relevant, such as market penetration, access to finance, or the rate of financial intermediation. Bank efficiency is likely to rise with deposit penetration (Dietsch and Lozano-Vivas, 2000; Lozano-Vivas et al., 2002) and a higher financial intermediation rate, which informs about the ability of banks to transform deposits into loans (Dietsch and Lozano-Vivas, 2000). Less access to finance, measured by lower branch density, may have a positive influence on bank efficiency, because costs of the branch network are saved (Dietsch and Lozano-Vivas, 2000; Lozano-Vivas et al., 2000). These factors will be controlled for in the following analysis, as long as they are not correlated too highly with the key factors and inputs.[4]

3. Methodology

3.1 Efficiency measures

To measure efficiency, we differentiate between technical, cost, revenue and scale efficiency.[5] A firm is technically efficient, if it maximizes output with a given level of inputs (output-oriented approach) or produces a given output with a minimum of inputs (input-oriented approach). A technically efficient bank is located on the production frontier (efficient frontier). For those banks that do not reach this frontier the degree of technical inefficiency is measured by the distance to the efficient frontier. The efficiency score is between 0 and 1 for a technically inefficient bank and 1 for a technically efficient bank.

Under the assumption of constant returns to scale, all firms operate at optimal scale, i.e., at the point where average costs are at a minimum. In reality, however, firms are likely to operate under decreasing or increasing returns to scale. Scale efficiency is defined as the amount by which a firm's efficiency could be improved by moving to its optimal scale (e.g., Ray, 2004; Coelli et al., 2005) and is calculated by dividing the efficiency score under constant returns to scale (CRS) by the efficiency score under variable returns to scale (VRS). A scale efficiency score of 1 indicates that a bank has reached its optimal size. The concept of scale efficiency decomposes the technical efficiency of a firm into pure technical efficiency and scale efficiency (Coelli et al., 2005).

[4] Banker and Natarajan (2008) show that a high correlation between input and environmental factors causes special problems.

[5] For a detailed explanation see Coelli et al. (2005).

The cost efficiency of a firm is defined by the ratio of minimum costs to actual costs for a given output vector. It ranges from 0 to 1, with a score of 1 representing a fully cost-efficient firm. Cost efficiency displays the product of allocative and technical efficiency; thus, a firm can be cost-efficient only if it is both allocatively and technically efficient (e.g., Ray, 2004). Allocative efficiency takes the input prices into account. A bank is allocatively efficient, if input factors are allocated so that production cost is minimized at given input prices.

If output quantities are also regarded as choice variables, profit efficiency can be calculated. Most previous studies on bank efficiency focus on cost efficiency, neglecting profit efficiency, which is a better measure to be considered when the objective is to measure bank performance (Chaffai and Dietsch, 2007). However, the concept of profit efficiency is not suitable to public savings banks in Germany, because their primary goal is not profit maximization, but striving for revenues to fulfill their public mandate.[6] Therefore, Bresler (2007) suggested the use of revenue efficiency, which measures whether a savings bank maximizes revenue at given input quantities and output prices. The revenue efficiency score informs about the achieved revenue relative to the maximum achievable revenue, which lies on the production frontier. In analogy to cost efficiency, revenue efficiency can be decomposed into technical and allocative efficiency. The latter informs about whether a bank produces an output mix that maximizes revenue at given input quantities and output prices.

To examine the influence of environmental factors on the efficiency of German savings banks, we proceed in two steps.

3.2 First step: Data Envelopment Analysis

In a first step, we apply modern frontier efficiency analysis to estimate technical, cost, revenue and scale efficiency of each bank. The methodology allows for the analysis of multiple input-output technologies. The performance of each firm is measured by comparing it to the efficient frontier of the industry, which is composed of the efficient firms in the reference set (e.g., all savings banks). The frontier analysis is suitable to examine scale economies and the influence of environmental factors on efficiency scores.

We estimate firm-specific efficiency using non-parametric DEA. Using DEA, an a priori specification of the underlying production function is not needed because the efficient best practice frontier is estimated by solving linear programming models to envelope the

[6] For empirical evidence see Conrad and Neuberger (2008), Wengler (2006) and Gärtner (2008).

observed data as tightly as possible (Charnes et al., 1978). It requires only convexity of the production possibility set and disposability of the inputs and outputs. This makes DEA especially useful when dealing with service industries, as knowledge about the sector's production technology is usually limited.

The DEA approach has been used by Radomski (2008) to examine the efficiency of German savings banks and the effects of mergers among them in the period 1994-2003. Bresler (2007), in contrast, used a parametric approach to estimate bank-individual efficiency scores and the success of mergers in the period 1996-2002, including for the first time external factors into an efficiency analysis of German savings banks. We use the non-parametric DEA approach, because it seems to be more advantageous (Varmaz, 2006; Radomski, 2008), at least for the present purpose.

3.3 Second step: regression analysis

In a second step, we estimate the influence of environmental factors on bank efficiency scores, following Wutz (2002) and Banker and Natarajan (2008). The DEA efficiency scores obtained in the first step are used as dependent variables in linear regression models. As independent variable we include the regional and demographic variables.

The methodology, explained in detail by Banker and Natarajan (2008), can be shortly described as follows. We assume a production equation $y_i (x) = y^{eff} (x) e^{Ei}$, with $E_i = -u_i$. $y_i (x)$ describes observable output and y^{eff} (x) efficient output at an input use of x. e^{Ei}, $E_i = -u_i$, describes the influence of inefficiency ($u_i > 0$, e.g. wasting) on production. If there is no wasting, i.e. $u_i = 0$, the observed output y_i (x) coincides with the efficient output $y^{eff}(x)$; otherwise, $y_i (x) < y^{eff} (x)$ so that $\phi_i < 1$ with $\phi_i = y_i (x) / y^{eff} (x) = e^{Ei} = e^{-ui}$.

If firm 1 is more efficient than firm 2, $\phi_1 = y_1/y^{eff} > \phi_2 = y_2/y^{eff}$, with $E_1 > E_2$ because of $u_1 < u_2$. This may be due to higher managerial waste in firm 2 than in firm 1. If, however, both firms operate in different environments, the efficiency differential may be caused by environmental factors. To take this into account, the inefficiency term E_i has to be extended by βz_i to $E_i = -u_i + \beta z_i$, where u_i denotes managerial inefficiencies, z_i is an environmental variable and β indicates the sign and size of the influence of z_i on y_i. If e.g. purchasing power is higher in the business area of firm 1 than in that of firm 2, $z_1 > z_2$. If at the same time $\beta > 0$ and $u_1 = u_2 = u$, we obtain $\phi_1 > \phi_2$ and $E_1 > E_2$. In this case, the efficiency gap between both firms is completely caused by the influence of the environmental variable. Thus, $\beta > 0$

indicates that regional purchasing power has a positive impact on bank efficiency, while the reverse holds if β < 0.

These relationships can be transformed into an OLS equation of the form $\ln(\phi_i) = \beta_0 + \sum_{i=1} \beta_i z_i + \varepsilon$, where ϕ indicates the individual efficiency scores obtained from the DEA analysis and z_i are the environmental variables.

Banker und Natarajan (2008) compare the performance of this two-stage approach with one-stage and two-stage parametric approaches. By way of Monte Carlo simulations they show that the use of DEA in the first step followed by OLS in the second step is appropriate to evaluate the impact of contextual variables on productivity. The performance of this approach is better in the estimation of individual productivity in the first step, and as well as the best of the parametric models in the estimation of the impact of environmental factors on productivity. OLS in the second step yields consistent estimators even if the contextual variables are correlated with each other.

3.4 Data and variables

We use bank-specific and regional data provided by the DSGV (Deutscher Sparkassen- und Giroverband) for the period 2001-2005. The regional data comprise population density, number of competitors, purchasing power and employment in the business area of each savings bank in each year. Information about the age structure and predicted development of the population is available not before 2007. Since large changes in the age and size of the population are unlikely within two years, we include 2007 data about age structure.

Using DEA requires identifying the relevant inputs and outputs of a savings bank. In the existing literature, the inputs and outputs of banks have been measured primarily using one of three approaches: the intermediation approach (mostly used, e.g. Wutz, 2002, Radomski 2008), the production approach (Bresler 2007, Radomski 2008), and the value-added approach (Radomski 2008).[7] We use all of them to test whether our results are robust to alternative banking models. According to the intermediation approach, banks are intermediaries, which use labor, physical capital and deposits as inputs to produce outputs such as loans and revenues. The production approach defines deposits, loans and other financial services as outputs, which are produced by employing labor and capital as classical inputs. The value-added approach considers those assets and liabilities as outputs which

[7] For a discussion of different banking models see e.g. Berger and Humphrey (1992).

have substantial value-added. According to this approach, loans, deposits and revenues are outputs, while labor, capital and interest expenses are inputs (Radomski, 2008).

Tables 1 and 2 provide an overview of the variables used as inputs and outputs in the first step of our analysis. Table 3 presents the measurement and descriptive statistics of the independent variables used in the second step.

Table 1: Inputs, outputs und prices – technical efficiency, cost and scale efficiency

	Outputs	Inputs	Prices
IA	customer loans commission earnings other ordinary earnings	customer deposits employees plant and equipment	average deposit rate personnel expenses/employees operating expenses/employees
PA	customer loans customer deposits branches	employees plant and equipment	personnel expenses/employees operating expenses/employees
VA	customer loans customer deposits commission earnings other ordinary earnings interest earnings	employees interest expense* plant and equipment	personnel expenses/employees price of interest expense = 1 operating expenses/employees

Notes: (IA) intermediation approach, (PA) production approach, (VA) value added approach, *interest expense = customer deposits x average deposit rate; for CRS and VRS model, respectively.
Source: on the basis of Radomski (2008, p. 82).

Table 2: Inputs and outputs – revenue efficiency

earnings *= Outputs x Output prices	commission earnings interest earnings other ordinary earnings
Inputs	employees plant and equipment customer deposits

Notes: *If information on output prices is missing, an alternative approach with price-based output information can be used (see Section 4.1.4 and Cooper et al., 2006, p. 255); for CRS and VRS model, respectively.

Table 3: Measurement and descriptive statistics of independent variables

		Mean		Standard deviation		Minimum value		Maximum value		Number of observations	
	Measurement	**2001**	**2005**	**2001**	**2005**	**2001**	**2005**	**2001**	**2005**	**2001**	**2005**
Key variables:											
- population density (*dens*)	number of inhabitants per km² in business area	420	422	548	554	40	36	3.782	4.330	426	427
- purchasing power (*purch*)	purchasing power in thousand Euro per inhabitant in business area	16.26	17.14	2.12	2.77	11.72	12.48	26.24	51.85	434	435
- population age (*old*) *	percent of inhabitants aged 75 or more in business area	-	0.08	-	0.01	-	0.02	-	0.30	-	427
- competition (*comp*)	number of competitor branches per savings bank branches in business area	2.38	1.37	0.93	0.40	0.50	7.8	7.90	434	434	
- bank size (*size*)	average volume of savings bank assets in thousand Euro per inhabitant of business area	12.06	12.68	4.35	4.72	3.42	3.48	52.18	56.79	434	435
Control variables (*control*):											
- equity capital (*equity*)	equity capital of savings bank in thousand Euro per inhabitant of business area	0.51	0.61	0.21	0.24	0.05	0.17	1.66	2.32	433	434
- branch penetration (*branch*)	number of savings bank branches per km² of business area	0.09	0.11	0.04	0.05	0	0.02	0.27	0.28	434	435
- unemployment (*unemp*)	unemployment rate in business area	0.07	0.06	0.06	0.05	0.004	0.004	0.42	0.35	426	427
- intermediation rate (*interm*)	Savings bank's debt claims to customers divided by liabilities to customers	0.83	0.84	0.26	0.25	0.19	0.17	2.02	1.81	434	422
- deposit density (*ddens*)	Savings bank's customer deposits in thousand Euro per inhabitant of business area	2.01	2.07	0.28	0.27	0.78	0.97	3.00	3.24	435	435

* For both years, information about population age in the business areas of the savings banks is missing. For 2005, we use 2007 data.

We estimate the following OLS equation:

$$\phi_i^{EC} = \beta_0 + \beta_1 dens_i + \beta_2 purch_i + \beta_3 old_i + \beta_4 comp_i + \beta_5 size_i + \varepsilon_i , \quad (1)$$

with ϕ_i^{EC} being the efficiency score of bank i for efficiency concept EC.

To investigate whether the influence of environmental factors on bank efficiency differs between declining and growing regions we use structural break models of the form

$$\phi_i^{EC} = \beta_0 + \beta_1 dens_i + \beta_2 (dens_i \times decline) + ... + \varepsilon_i \quad (2)$$

The variable *decline* is a dummy variable which takes the value 1, if bank i is located in a declining region, i.e. a region where population is expected to decline in the period 2001-2025, and value 0 otherwise. Thus, β_1 indicates the influence of population density on the efficiency of banks in growing regions, and $\beta_1+\beta_2$ indicates the influence of population density on the efficiency of banks in declining regions.

4. Results

4.1 First step results

In the following, we present the results of the DEA estimations of technical efficiency, scale, cost and revenue efficiency for the years 2001-2005, differentiated according to the intermediation, production and value added approach .

4.1.1 Technical efficiency

ϕ_j^{TC} is the (input-oriented) technical efficiency score of bank j, which takes a value of 1 if the bank is on the production frontier and a value between 0 and 1 if it uses too much input to produce the same output. Each bank uses K input factors with quantities x_{ki} (k = 1, . . . ,K) to produce M outputs with quantities y_{mi} (m = 1, . . . ,M). Technical efficiency is calculated by solving the following optimization problem for each individual savings bank i (i = 1,…,j,…,N):[8]

$$\underset{\lambda,\theta}{Min}\,\theta_j^{TE} \quad (3)$$

s.t.

$$\theta_j^{TE} x_{kj} \geq \sum_{i=1}^{N} \lambda_i x_{ki}$$

[8] See Coelli et al. (2005, pp.162).

$$y_{mj} \leq \sum_{i=1}^{N} \lambda_i y_{mi}$$

$$\lambda_i \geq 0$$

This holds under the assumption of a production process with constant returns to scale (CRS). In the case of variable returns to scale (VRS), the constraint $\Sigma_{i=1}^{N}\lambda_i = 1$ has to be added.

The solutions of this problem are presented in Table 4 (see also Tables A.1-A.3 in the appendix).

Table 4: Technical efficiency of savings banks – overview of results

		2001 n = 433	2002 n = 435	2003 n = 435	2004 n = 435	2005 n = 435
IA	Ø	0.77	0.74	0.72	0.74	0.74
	σ	0.11	0.12	0.12	0.12	0.12
	Min	0.49	0.50	0.49	0.47	0.47
	1st quartile	0.68	0.65	0.62	0.64	0.64
	2nd quartile	0.76	0.73	0.70	0.72	0.72
	3rd quartile	0.84	0.83	0.80	0.82	0.81
	Eff	34	29	20	28	26
PA	Ø	0.74	0.73	0.71	0.71	0.70
	σ	0.11	0.11	0.10	0.11	0.11
	Min	0.52	0.51	0.51	0.50	0.49
	1st quartile	0.66	0.65	0.63	0.63	0.62
	2nd quartile	0.72	0.71	0.69	0.69	0.68
	3rd quartile	0.79	0.79	0.76	0.77	0.75
	Eff	25	25	17	17	18
VA	Ø	0.78	0.76	0.74	0.76	0.75
	σ	0.11	0.11	0.11	0.11	0.11
	Min	0.50	0.51	0.51	0.56	0.54
	1st quartile	0.69	0.67	0.66	0.66	0.66
	2nd quartile	0.76	0.75	0.72	0.74	0.74
	3rd quartile	0.85	0.84	0.82	0.83	0.83
	Eff	36	31	24	29	27

Notes: results of VRS (variable returns to scale) model; (IA) intermediation approach, (PA) production approach, (VA) value added approach; 1st quartile= 25 % of the banks reach at most this efficiency score ; 2nd quartile (median) = 50 % of the banks reach at most this efficiency score; 3rd quartile = 75 % of the banks reach at most this efficiency score; Ø= mean, σ = standard deviation; Min = minimum value, Eff = number of efficient ('best practice') banks.

In the year 2005 (2001), technical efficiency (VRS model) of savings banks reached an average of 73% (77%) for the intermediation approach, 70% (74%) for the production approach and 75% (78%) for the value added approach. This indicates that the banks could have reduced their inputs on average by about 25% (IA and VA) or 30% (PA), without reducing their outputs. Thus, public savings banks in Germany seem to face difficulties in utilizing resources productively. A possible explanation is that they are engaged in activities to fulfill their public mission, producing outputs out of their balance sheets. In 2005, the efficient frontier (VRS) given by the best practice institutes is composed of 26 (IA), 18 (PA) and 27(VA) banks, respectively.

Based on the estimations for the whole sample, we find that the number of best practice institutes is absolutely and relatively higher in West than in East Germany, but that the average efficiency scores do not differ remarkably between both regions (see Tables A.4, A.5, column (1), in the appendix).[9] If, however, efficiency is estimated separately for different subgroups, we find that average technical efficiency (VRS) is relatively high with 90% (IA, 2005) and has a small variation in East Germany, compared to West Germany with 74% and a larger variation (see Tables A.4, A.5, column (2) in the appendix). This might be due to the fact that East Germany is less heterogeneous with respect to economic and demographic factors than West Germany, and that these environmental factors are relevant for technical efficiency. Banks in regions with high (above the median) population density reach higher efficiency levels than those in regions with low population density (see Tables A.6, A.7 in the appendix). Banks in regions with high (above the median) economic power reach higher technical efficiency than those in poorer regions (see Tables A.8, A.9 in the appendix). In declining and growing regions, the shares of technically efficient banks and the average efficiency levels are about the same (see Tables A.10, A.11 in the appendix). A possible explanation is heterogeneity within both subgroups. As shown by Conrad and Neuberger (2008), all types of regions are declining, densely populated and rich regions as well as rural and poor ones. In contrast, the technical efficiency of savings banks differs according to regional population density and economic power.

[9] We present only the IA results, which do not differ qualitatively from the PA and VA results.

4.1.2 Scale efficiency

The bank individual scale efficiency scores are calculated by dividing technical efficiency under constant returns to scale by technical efficiency under variable returns to scale: $\phi_j^{TE,CRS} / \phi_j^{TE,VRS}$. The results are presented in Table 5.

Table 5: Scale efficiency of savings banks – overview of results

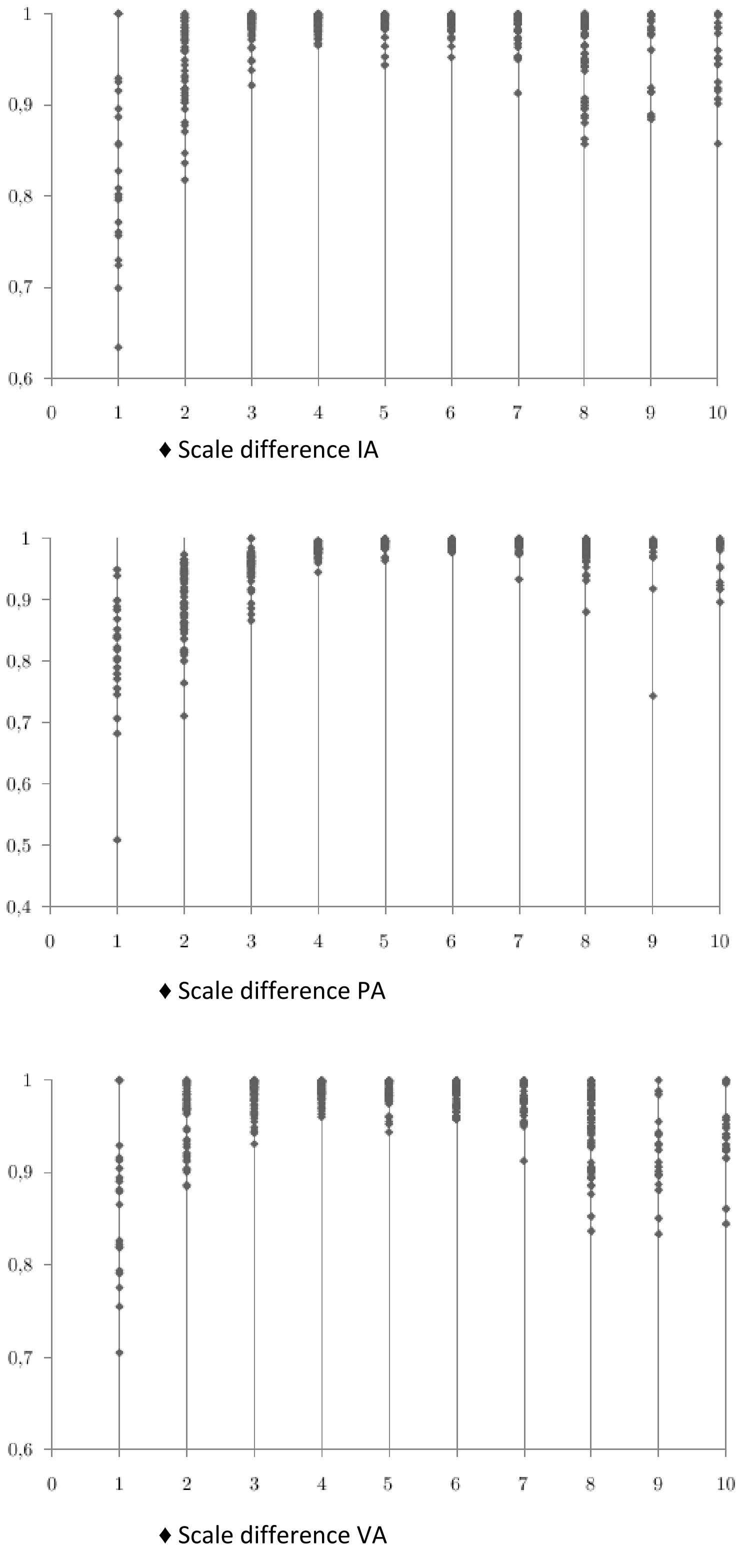
		2001 n = 433	2002 n = 435	2003 n = 435	2004 n = 435	2005 n = 435
IA	Ø	0.97	0.96	0.96	0.96	0.96
	σ	0.04	0.05	0.05	0.05	0.04
	Min	0.68	0.65	0.63	0.62	0.63
	Eff	17	17	10	15	18
PA	Ø	0.96	0.96	0.96	0.96	0.95
	σ	0.04	0.05	0.06	0.05	0.05
	Min	0.71	0.60	0.59	0.50	0.50
	Eff	12	13	6	7	6
VA	Ø	0.96	0.96	0.96	0.96	0.96
	σ	0.04	0.04	0.04	0.04	0.04
	Min	0.68	0.71	0.71	0.71	0.70
	Eff	17	17	15	17	18

Notes: (IA) intermediation approach, (PA) production approach, (VA) value added approach; Ø= mean, σ = standard deviation; Min = minimum value, Eff = number of efficient ('best practice') banks.

Scale efficiency is high in all three bank models, with average scores of 95-96% (2005). Thus, savings banks have only little potential to become more efficient by changing their size. However, this does not hold for those banks with the lowest efficiency scores, which reached only 63% (IA), 50% (PA) or 70% (VA) of the banks on the efficient frontier. To examine optimum size, we follow Radomski (2008, p. 95) and illustrate scale efficiency in different size classes. Figure 1 shows that the optimal bank size is in the range of 900-2,500 million Euro, where scale efficiency is highest.

Also the results of estimations for different subgroups of regions (see Tables A.4-A.11 in the appendix) do not show clear differences in scale efficiency. The savings banks seem to have well adapted their size to the given environment in their business area. Therefore, we do not expect that environmental factors have a relevant impact on scale efficiency.

Figure 1: Scale efficiency of savings banks - results



Notes: the efficiency scores of savings banks (2005) based on the (IA) intermediation approach, (PA) production approach, and (VA) value added approach are presented for ten size classes (following Radomski, 2008) in million Euro: (1) < 300, (2) 300-600, (3) 600-900, (4) 900-1200, (5) 1200-1500, (6) 1500-2000, (7) 2000-2500, (8) 2500-5000, (9) 5000-7500, (10) ≥ 7500.

4.1.3 Cost efficiency

Cost efficiency is calculated by taking into account also input prices. With w_{kj}, the price of input factor k of bank j, and C_j, the total cost of bank j, the optimization problem (under CRS) is given as follows: [10]

$$C_j = \underset{\lambda, x^*_{kj}}{Min} \sum_{k=1}^{K} w_{kj} x^*_{kj} \tag{4}$$

s.t.

$$x^*_{kj} \geq \sum_{i=1}^{N} \lambda_i x_{ki}$$

$$y_{mj} \leq \sum_{i=1}^{N} \lambda_i y_{mi}$$

$$\lambda_i \geq 0$$

In the case of variable returns to scale (VRS), the constraint $\Sigma_{ii=1}^{N} \lambda_i = 1$ has to be added. The relation between the cost minimizing factor combination, x^*_{kj}, and the actually used input quantities, x_{kj}, both weighted by input prices, indicates cost efficiency ϕ_j^{CE} of bank j:

$$\theta_j^{CE} = \frac{\sum_{k=1}^{K} w_{kj} x^*_{kj}}{\sum_{k=1}^{K} w_{kj} x_{kj}} \tag{5}$$

Table 6 shows the results for the years 2001-2005 under the assumption of VRS for the three different banking models (see also appendix A.1-A.3).

In 2005 (2001), the average cost efficiency score was 61% (68%) (IA), 68% (71%) (PA) and 64% (69%) (VA). In 2005, the 25% least efficient banks reached maximum efficiency levels of 52% (IA), 61% (PA) or 59% (VA), while the 25% most efficient banks reached efficiency levels of at least 69% (IA), 61% (PA) or 71% (VA). Thus, most banks have large potentials to reduce cost at given output.

[10] See Coelli et al. (2005, pp. 162).

Table 6: Cost efficiency of savings banks – overview of results

		2001	2002	2003	2004	2005
		n = 433	n = 435	n = 435	n = 435	n = 435
	Ø	0.68	0.64	0.61	0.62	0.61
	σ	0.11	0.11	0.11	0.12	0.12
	Min	0.44	0.44	0.38	0.37	0.38
IA	1st quartile	0.60	0.51	0.52	0.51	0.52
	2nd quartile	0.66	0.62	0.59	0.59	0.59
	3rd quartile	0.73	0.70	0.69	0.69	0.69
	Eff	9	7	8	9	9
	Ø	0.71	0.71	0.70	0.69	0.68
	σ	0.10	0.10	0.10	0.11	0.11
	Min	0.51	0.50	0.48	0.49	0.48
PA	1st quartile	0.63	0.64	0.63	0.62	0.61
	2nd quartile	0.69	0.64	0.68	0.67	0.54
	3rd quartile	0.76	0.76	0.75	0.75	0.61
	Eff	13	14	12	12	14
	Ø	0.69	0.67	0.64	0.65	0.64
	σ	0.10	0.10	0.11	0.11	0.11
	Min	0.50	0.47	0.44	0.44	0.45
VA	1st quartile	0.61	0.59	0.56	0.56	0.59
	2nd quartile	0.67	0.65	0.61	0.62	0.62
	3rd quartile	0.75	0.73	0.70	0.71	0.71
	Eff	11	8	7	9	8

Notes: results of VRS (variable returns to scale) model; (IA) intermediation approach, (PA) production approach, (VA) value added approach; 1st quartile= 25 % of the banks reach at most this efficiency score ; 2nd quartile (median) = 50 % of the banks reach at most this efficiency score; 3rd quartile = 75 % of the banks reach at most this efficiency score; Ø= mean, σ = standard deviation; Min = minimum value, Eff = number of efficient ('best practice') banks.

The efficient frontier (VRS, 2005) is determined by 9 (IA), 14 (PA), respectively 8 (VA) best practice institutes. As only one of them is located in East Germany (all three models), there are absolutely and relatively more efficient banks in West Germany. For the estimations based on the whole sample, average cost efficiency does not differ remarkably between both regions. If, however, cost efficiency is estimated separately for the subsamples East and West Germany, we find higher efficiency in East Germany. In 2005 (VRS), cost efficiency in East vs. West Germany was 79 vs. 62% (IA), 82 vs. 69% (PA), respectively 81 vs. 65% (VA).[11] As in the case of technical efficiency, the variation of cost efficiency is lower in East Germany, which might be due to a more homogeneous environment, than in West Germany.

[11] The results for IA are presented in Tables A.4 and A.5 in the appendix.

Comparing cost efficiency between regions with high and low population density or economic power and between growing and declining regions, the results for the whole sample show that average cost efficiency is comparatively high in regions with high population density or economic power. Estimations for the respective subsamples, however, show that banks in regions with low population density or economic power or those in declining regions are on average more cost efficient than those in the respective comparison group (see Tables A.6-A.11 in the appendix). The former seem to be relatively homogeneous in their ability to adapt to an unfavorable environment. Savings banks in densely populated, rich or growing regions are more heterogeneous, with many ‘best practice’ banks, but also many inefficient banks.

4.1.4 Revenue efficiency

Revenue efficiency is calculated by taking into account also output prices. If data about output prices are not available, price-based output measures can be used instead (Cooper et al., 2006, p. 255). In this case, total revenue of bank j is given by: $R_j = \Sigma_{m=1}^{M} \bar{y}_{mj} = p_{mj} y_{mj}$, with $\bar{y}_{mj}$ as price-based output, p_{mj} as price of output m and y_{mj} as quantity of output m produced by bank j. The optimal price-based output that maximizes revenues for a given input is determined by solving the following system of equations:

$$R_j = \underset{\lambda, \bar{y}_m^*}{\mathrm{Max}} \sum_{m=1}^{M} \bar{y}_{mj}^* \tag{6}$$

$$\text{s.t.}$$

$$x_{kj} \geq \sum_{i=1}^{N} \lambda_i x_{ki}$$

$$\bar{y}_{mj}^* \leq \sum_{i=1}^{N} \lambda_i \bar{y}_{mi}$$

$$\lambda_i \geq 0$$

By dividing the output level actually used, $\bar{y}_{mj}$, by the optimal price-based output, $\bar{y}_{mj}^*$, we obtain the revenue efficiency score of bank j :

$$\theta_j^{RE} = \frac{\sum_{m=1}^{M} \bar{y}_{mj}}{\sum_{m=1}^{M} \bar{y}_{mj}^*} \tag{7}$$

Table 7 presents the results for 2001-2005 under the assumption of VRS and CRS for the intermediation approach (see also Table A.1 in the appendix).[12] In 2005 (2001), average revenue efficiency (VRS) was 76% (78%), and lowest revenue efficiency was 53% (53%).Thus, savings banks may increase their revenues on average by about 25% by producing higher output at given inputs and output prices. The 25% least efficient banks may increase their revenues by even a third. Savings banks in regions with low population density or economic power show on average lower revenue efficiency levels than those in densely populated or rich regions (see Tables A.4-A.11 in the appendix). Savings banks in peripheral and poor regions seem to be more highly involved in fulfilling their public mandate (Schrumpf and Müller, 2001; Conrad and Neuberger, 2008).

Table 7: Revenue efficiency of savings banks – overview of results

		2001 n = 433	2002 n = 435	2003 n = 435	2004 n = 435	2005 n = 435
VRS	Ø	0.78	0.76	0.75	0.76	0.76
	σ	0.11	0.11	0.11	0.11	0.11
	Min	0.53	0.52	0.53	0.53	0.53
	1st quartile	0.69	0.67	0.66	0.67	0.67
	2nd quartile	0.76	0.74	0.73	0.74	0.74
	3rd quartile	0.85	0.84	0.82	0.83	0.83
	Eff	36	31	24	29	27
CRS	Ø	0.75	0.74	0.72	0.73	0.73
	σ	0.11	0.11	0.10	0.10	0.11
	Min	0.49	0.50	0.53	0.52	0.52
	1st quartile	0.67	0.66	0.64	0.65	0.65
	2nd quartile	0.74	0.72	0.70	0.71	0.71
	3rd quartile	0.82	0.81	0.79	0.80	0.79
	Eff	17	17	15	17	18

Notes: results of VRS/CRS (variable returns to scale/constant returns to scale) model; 1st quartile= 25 % of the banks reach at most this efficiency score ; 2nd quartile (median) = 50 % of the banks reach at most this efficiency score; 3rd quartile = 75 % of the banks reach at most this efficiency score; Ø= mean, σ = standard deviation; Min = minimum value, Eff = number of efficient ('best practice') banks.

Group individual calculations show that savings banks in East Germany are on average more revenue efficient than those in West Germany, with efficiency scores of 94% vs. 76% in 2005. Similarly, revenue efficiency is higher in regions with low economic power than in those with high economic power (83% vs. 79% in 2005). Again, this may result from higher homogeneity of East German and relatively poor regions. In contrast, revenue efficiency

[12] Because of missing data, revenue efficiency could not be calculated for the production and intermediation approach.

does not differ remarkably between banks in regions with low vs. high population density or in declining vs. growing regions.

In sum, we find that on the one hand, most savings banks still have scope for increasing revenue efficiency, irrespective of their environment. On the other hand, many savings banks have already reached high revenue efficiency and thus seem to be well adapted to their environment.

4.2 Second step results

To examine the influence of environmental factors on the above efficiency scores, we employ multivariate regressions on group means for the years 2001-2005. Using average values of bank-individual efficiency and environmental factors helps to compensate the influence of stochastic variations and gaps in the data set. To test the robustness of the results, we estimated first-difference equations for the years 2001 and 2005, as well as truncated regression models that take into account that the dependent variable is restricted to values between 0 and 1 (e.g. Simar and Wilson, 2007). Since the results do not differ qualitatively, we do not present them. We also do not present the results regarding scale efficiency, because environmental factors do not show a relevant influence on scale efficiency. This has been expected above, given that scale efficiency is high on average and varies little.

The key and control variables described in Table 3 are in part highly correlated. Therefore, we estimated two models separately: M1 includes only the key variables, and M2 includes only the control variables as independent variables. [13] The results concerning the influence of the dummy variable *decline* are only presented, if the influence is significant. This means that coefficients which are not related to a dummy variable indicate the influence of the respective independent variable on bank efficiency for whole Germany.

4.2.1 Environmental factors and technical efficiency

Tables 8 and 9 present the results about the influence of regional and demographic factors on the technical efficiency of savings banks.

[13] Since the control variable *interm* is highly correlated with the input variables, we did not include it in the regressions. See Banker and Natarajan (2008).

Table 8: Impact of environmental factors on technical efficiency – results (M1)

	OLS regression dependent variable = technical efficiency					
	IA		PA		VA	
Independent variable	VRS n = 2061	CRS n = 2061	VRS n = 2063	CRS n = 2063	VRS n = 2061	CRS n = 2061
dens	***0.0061	***0.0061	0.00085	0.0019	***0.0055	***0.0053
dens x decline	***-0.0058	**-0.0046	-0.0028	-0.0029	**-0.0042	**-0.0035
purch	*-0.56	***-0.76	-0.22	-0.31	**-0.66	***-0.89
purch x decline	***0.86	***0.59	***0.91	***0.79	***0.97	***0.78
old	51.26	45.16	***82.72	***75,54	44.79	39.56
old x decline	***-135.06	**-96.07	***-158.85	***-146.18	***-164.66	***-136.36
comp	***1.79	***1.81	***1.34	0.44	***2.06	***1.89
size	***0.75	***0.77	***0.68	***0.53	***0.96	***0.98
const	***63.77	***64.87	***57.03	***60.29	***64.71	***66.78
R^2	0.128	0.132	0.114	0.089	0.203	0.212
F-test	***7.67	***7.98	***6.75	***5.13	***13.32	***14.11

Notes: coefficients multiplied by 100; results for means of years 2001-2005, except for variables *old* and *old x decline* with 2005 values ; panel regressions with group means, group number = 427 (= number of savings banks); significance levels: *** p ≤ 1%, ** p ≤ 5%, * p ≤ 10%; (IA) intermediation approach, (PA) production approach, (VA), value added approach; V RS/CRS = variable/constant returns to scale.

Table 9: Impact of environmental factors on technical efficiency – results (M2)

	OLS regression dependent variable = technical efficiency					
	IA		PA		VA	
Independent variable	VRS n = 2121	CRS n = 2121	VRS n = 2122	CRS n = 2122	VRS n = 2121	CRS n = 2121
branch	***0.50	***0.49	0.063	0.13	***0.49	***0.44
branch x decline	***-0.55	***-0.53	-0.11	0.082	**-0.45	**-0.41
ddens	***-0.016	***-0.016	0.0090	0.0080	*-0.0092	*-0.0086
ddens x decline	*-0.012	-0.009	0.00056	0.0070	**-0.013	*-0.011
unemp	***0.58	***0.68	0.0010	0.0023	***0.42	***0.50
equity	***0.20	***0.22	0.0087	0.010	***0.15	***0.16
equity x decline	**0.21	*0.15	0.0019	-0.10	**0.21	**0.17
const	***0.68	***0.63	***0.63	***0.61	***0.68	***0.64
R^2	0.138	0.158	0.044	0.055	0.128	0.144
F - test	***9.65	***11.27	***2.80	***3.54	***8.82	***10.11

Notes: results for means of years 2001-2005; panel regressions with group means, group number = 427 (= number of savings banks); significance levels: *** p ≤ 1%, ** p ≤ 5%, * p ≤ 10%; (IA) intermediation approach, (PA) production approach, (VA), value added approach; V RS/CRS = variable/constant returns to scale.

While the results are very similar for the intermediation and value-added approach, the production approach partly finds other significance levels. Therefore, we discuss the IA and

VA results. Population density (M1) exerts a highly significant positive influence on technical efficiency in growing regions. This result is consistent with the first step result that most best practice banks are located in central, agglomerated regions. Also in declining regions, technical efficiency increases with population density, however to a much smaller degree near zero.

Also the control variable branch density (M2), which measures access to finance and is closely related to population density, has a highly significant positive effect on technical efficiency in growing regions. Thus, banks in growing regions can improve their technical efficiency by increasing branch penetration. For banks in declining regions, in contrast, the influence of branch density on technical efficiency is negative and near zero.

The influence of purchasing power (M1) on technical efficiency is large and negative in growing regions (VRS and CRS), but small and positive (VRS) or negative (CRS) in declining regions. These results are inconsistent with our expectation of a positive influence (see Section 2), which is only partly supported for declining regions. The results for the control variables deposit density and unemployment (M2) point into the same direction: deposit density has a negative influence on technical efficiency in growing and declining regions, and unemployment has a positive influence in all regions. Since unemployment rate is negatively correlated and deposit density is positively correlated with economic power (Conrad and Neuberger 2008), both are alternative measures for economic power. Summing up, we find a negative influence of economic power on technical efficiency of savings bank.

Population age (M1) shows a positive influence on technical efficiency in growing regions, which, however, is only significant when applying the production approach. In declining regions, it shows a large and significant negative influence in all models. Consistent with our expectations, savings banks in declining regions with a larger share of elder people are less technically efficient than their counterparts in growing and 'younger' regions.

A higher intensity of competition (M1) goes along with higher technical efficiency in the whole country, consistent with the market-structure or quiet life hypothesis. Also bank size (M1) and equity capital (M2), which are highly correlated, have a positive influence on technical efficiency overall. The higher efficiency of larger banks is contrary to the findings of Bresler (2007). [14]

The R² values indicate that environmental factors have a quite large explanatory power. They explain up to 21% (M1, CRS, VA), respectively 16% (M2, CRS, IA) of the variation of bank individual technical efficiency scores.

4.4.2 Environmental factors and cost efficiency

The results about the influence of regional and demographic factors on the cost efficiency of savings banks are presented in Tables 10 and 11. Again, the intermediation and value added approaches yield very similar results.

Table 10: Impact of environmental factors on cost efficiency – results (M1)

OLS regression dependent variable = cost efficiency	IA		PA		VA	
Independent variable	VRS n = 2061	CRS n = 2061	VRS n = 2063	CRS n = 2063	VRS n = 2061	CRS n = 2061
dens	***0.0062	***0.0072	0.00032	0.0017	***0.0058	***0.0061
dens x decline	***-0.0067	***-0.0049	-0.0026	*-0.0031	***-0.0055	**-0.0036
purch	*-0.47	*-0.47	-0.15	-0.23	**-0.55	**-0.45
purch x decline	***0.82	**0.45	***0.84	***0.76	***0.91	***0.61
old	*56.42	38.20	***83.91	***72.32	*50.31	33.96
old x decline	***-121.63	**-78.43	***-151.12	***-144.65	***-147.55	***-113.91
comp	***2.18	***1.16	***1.51	0.088	***2.08	***1.13
size	***0.85	***0.77	***0.70	***0.46	***1.01	***0.88
const	***48.67	***48.54	***53.64	***59.59	***51.73	***51.19
R^2	0.170	0.194	0.129	0.085	0.231	0.256
F - test	***10.73	***12.63	***7.74	***4.91	***15.72	***18.06

Notes: coefficients multiplied by 100; results for means of years 2001-2005, except for variables *old* and *old x decline* with 2005 values ; panel regressions with group means, group number = 427 (= number of savings banks); significance levels: *** p ≤ 1%, ** p ≤ 5%, * p ≤ 10%; (IA) intermediation approach, (PA) production approach, (VA), value added approach; V RS/CRS = variable/constant returns to scale.

[14] The different results may also be due to different measurements of bank size. In contrast to Bresler (2007), we do not consider the absolute size, but the relative size (per inhabitant). The relationship between absolute size and efficiency is not linear, but has a quadratic shape.

Table 11: Impact of environmental factors on cost efficiency – results (M2)

OLS regression dependent variable = cost efficiency	IA		PA		VA	
Independent variable	VRS n = 2121	CRS n = 2121	VRS n = 2122	CRS n = 2122	VRS n = 2121	CRS n = 2121
branch	***0.42	***0.53	0.017	0.12	***0.41	***0.48
branch x decline	***-0.52	***-0.46	-0.070	-0.048	**-0.44	**-0.34
ddens	-0.0056	-0.0019	*0.0098	*0.0082	-0.000025	0.0037
ddens x decline	*-0.0057	-0.0036	0.0022	0.0087	-0.0067	-0.0053
unemp	***0.49	***0.57	-0.044	-0.069	***0.33	***0.33
equity	**0.14	**0.13	0.0068	0.0014	*0.10	0.071
equity x decline	0.11	0.045	-0.033	*-0.14	0.11	0.065
const	***0.53	***0.45	***0.62	***0.61	***0.55	***0.49
R^2	0.091	0.149	0.051	0.063	0.097	0.144
F - test	***6.01	***10.51	***3.27	***4.08	***6.46	***10.13

Notes: results for means of years 2001-2005; panel regressions with group means, group number = 427 (= number of savings banks); significance levels: *** p ≤ 1%, ** p ≤ 5%, * p ≤ 10%; (IA) intermediation approach, (PA) production approach, (VA), value added approach; V RS/CRS = variable/constant returns to scale.

Population age (M1) shows a slightly significant positive influence on cost efficiency in growing regions, but a highly significant and large negative influence on cost efficiency in declining regions. Consistent with our expectations, savings banks in declining and ‘older’ regions are less cost efficient than their counterparts in growing and ‘younger' regions.

As in the case of technical efficiency, the environmental factors competition (M1), bank size (M1) and equity capital (M2) have a positive effect on cost efficiency. It is significant in most cases, with the exception of the influence of equity capital in declining regions. Bank equity is less likely to be a short production factor in declining regions.

Again, the environmental factors have a relevant influence on efficiency. They explain up to 25% (M1, CRS, VA), respectively 15% (M2, CRS, IA) of the variation of bank individual cost efficiency scores.

4.2.3 Environmental factors and revenue efficiency

The results about the influence of regional and demographic factors on the revenue efficiency of savings banks, based on the intermediation approach, are presented in Tables 12 and 13.

Table 12: Impact of environmental factors on revenue efficiency – results (M1)

OLS regression dependent variable = revenue efficiency		
	IA	
Independent variable	VRS n = 2061	CRS n = 2061
dens	***0.0055	***0.0053
dens x decline	*-0.0035	**-0.0034
purch	**-0.64	***-0.86
purch x decline	***0.81	***0.76
old	39.42	38.96
old x decline	***-141.45	***-133.92
comp	***2.09	***1.89
size	***0.97	***0.97
const	***65.17	***66.71
R^2	0.212	0.214
F - test	***14.06	***14.28

Notes: coefficients multiplied by 100; results for means of years 2001-2005, except for variables *old* and *old x decline* with 2005 values ; panel regressions with group means, group number = 427 (= number of savings banks); significance levels: *** p ≤ 1%, ** p ≤ 5%, * p ≤ 10%; (IA) intermediation approach, (PA) production approach, (VA), value added approach; V RS/CRS = variable/constant returns to scale.

Table 13: Impact of environmental factors on revenue efficiency – results (M2)

OLS regression dependent variable = revenue efficiency		
	IA	
Independent variable	VRS n = 2121	CRS n = 2121
branch	***0.50	***0.44
branch x decline	**-0.42	**-0.41
ddens	-0.0077	*-0.0085
ddens x decline	**-0.014	*-0.011
unemp	***0.44	***0.50
equity	**0.14	***0.16
equity x decline	***0.21	**0.17
const	***0.68	***0.64
R^2	0.138	0.146
F - test	***9.61	***10.27

Notes: results for means of years 2001-2005; panel regressions with group means, group number = 427 (= number of savings banks); significance levels: *** p ≤ 1%, ** p ≤ 5%, * p ≤ 10%; (IA) intermediation approach, (PA) production approach, (VA), value added approach; V RS/CRS = variable/constant returns to scale.

Again, we find that savings banks in densely populated regions are more efficient than those in less densely populated ones, with a much stronger impact in growing than in declining regions. Branch density shows a similar impact. Also the variables measuring economic power have similar effects as above. The influence of purchasing power is again negative in growing regions, but positive/negative (VRS/CRS) with negligible size in declining regions. Deposit density also shows a negative influence on revenue efficiency, but more clearly so in declining regions. Unemployment has always a significant positive influence on revenue efficiency. These results are contrary to our expectations. Population age shows a significant influence on revenue efficiency only in declining regions, where it is negative, as above. Savings banks in regions with are larger number of competitors are also more revenue efficient than their counterparts in less competitive regions. Revenue efficiency also increases with bank size and equity capital. In contrast to the results for cost efficiency, equity capital has a larger effect on revenue efficiency in declining regions.

The explanatory power of the estimations varies between 14% (M2) and 21% (M1). Hence, up to a fifth of the variation of revenue efficiency of savings banks can be explained by regional and demographic factors.

5. Conclusions

This paper examines the influence of environmental factors on the efficiency of public savings banks in Germany for the period 2001-2005. In a first step, bank-individual efficiency scores are estimated using a data envelopment analysis. In a second step, the efficiency scores are regressed on various regional and demographic factors. The paper contributes to the empirical literature on the influence of environmental factors on bank efficiency mainly in three aspects: first, it examines the whole range of efficiency measures – technical, cost, scale and revenue efficiency. Secondly, it employs the whole range of banking models – the intermediation, production and value added approach. Third, it differentiates between declining and growing regions, taking into account regional disparities in economic wealth and population age, which tend to increase through demographic developments.

The analysis in the first step shows that most of the savings banks are highly efficient, with average efficiency levels (in 2005) of about 75% for technical and revenue efficiency and 96% for scale efficiency. However, cost efficiency levels reach on average only 60%. Thus, savings banks seem to be able to increase their efficiency mainly by better utilizing resources. However, this conclusion neglects that only part of the observed inefficiencies may result from managerial behavior, while the other part is likely to be determined by the bank's environment. Moreover, the results are based on banking models that do not take into account the public mandate of German savings banks to foster regional development. Regional comparisons show that there are relatively more best practice banks in West Germany than in the East, but that savings banks in East Germany are less heterogeneous in efficiency levels. The most efficient banks tend to be located either in very densely populated and rich regions or in peripheral and poor regions. Savings banks in declining and economically weaker regions are more homogeneous in efficiency, but less efficient than those in growing and prosperous regions.

The results of the second step show that environmental factors are clearly relevant for the explanation of technical, cost and revenue efficiency of savings banks, with the highest explanatory power in the case of cost efficiency. Regional population density and branch penetration in the business area have a positive impact on all three efficiency measures, but mainly or exclusively in growing regions. Thus, savings banks in declining and peripheral regions are disadvantaged and have no scope for improving efficiency by changing their branch density. This finding may indicate that they are already adapted to their environment. Contrary to our expectations, regional economic power (purchasing power, employment rate, deposit density) has a negative influence on technical, cost and revenue efficiency. An explanation is that savings banks in prosperous regions enjoy a quiet life, which causes higher managerial slackness. Our finding that efficiency levels are higher in more competitive environments also supports the quiet life hypothesis (contrary to Wutz 2002). Population age is relevant for savings banks in declining regions, where a larger share of elder people has a negative influence on technical, cost and revenue efficiency. Elder people tend to have less demand for financial services and prefer standardized products distributed by cost-intensive branches. By servicing these customers in local markets, savings banks fulfill their public mission. Their ability to do this efficiently depends on their relative size or equity capital. Banks that do not adapt their size to a decline in the regional population tend to be less technically, cost and revenue efficient.

All in all, we find that savings banks that operate under unfavorable economic and demographic conditions seem to be quite well adapted to their environments, showing relatively high levels of technical, cost and revenue efficiency. Thus, they have the potential to remain competitive and continue to fulfill their public mission.

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Appendix

Table A.1: Results for intermediation approach – all savings banks

	2001 n = 433	2002 n = 435	2003 n = 435	2004 n = 435	2005 n = 435
Ø TE_{VRS}	0.77	0.74	0.72	0.74	0.74
σ	0.11	0.12	0.12	0.12	0.12
Min	0.49	0.50	0.49	0.47	0.47
Eff	34	29	20	28	26
Ø TE_{CRS}	0.75	0.72	0.69	0.71	0.71
σ	0.11	0.12	0.11	0.11	0.12
Min	0.46	0.38	0.37	0.40	0.41
Eff	17	17	10	15	18
Ø *SE*	0.97	0.96	0.95	0.96	0.96
σ	0.04	0.05	0.05	0.05	0.04
Min	0.68	0.65	0.63	0.62	0.63
Eff	17	17	10	15	18
Ø CE_{VRS}	0.68	0.64	0.61	0.62	0.61
σ	0.11	0.11	0.11	0.12	0.12
Min	0.44	0.44	0.38	0.37	0.38
Eff	9	7	8	9	9
Ø CE_{CRS}	0.63	0.59	0.56	0.55	0.56
σ	0.09	0.10	0.10	0.11	0.11
Min	0.41	0.34	0.30	0.29	0.28
Eff	4	5	4	4	5
Ø RE_{VRS}	0.78	0.76	0.75	0.76	0.76
σ	0.11	0.11	0.11	0.11	0.11
Min	0.53	0.52	0.53	0.53	0.53
Eff	36	31	24	29	27
Ø RE_{CRS}	0.75	0.74	0.72	0.73	0.73
σ	0.11	0.11	0.10	0.10	0.11
Min	0.49	0.50	0.53	0.52	0.52
Eff	17	17	15	17	18

Notes: TE = technical efficiency, SE = scale efficiency, CE = cost efficiency, RE = revenue efficiency; CRS/V RS = constant/variable returns to scale; Ø = mean, σ = standard deviation, Min = minimum value; Eff = number of efficient ('best practice') banks.

Table A.2: results for production approach – all savings banks

	2001 n = 434	2002 n = 435	2003 n = 435	2004 n = 435	2005 n = 435
Ø TE_{VRS}	0.74	0.73	0.71	0.71	0.70
σ	0.11	0.11	0.10	0.11	0.11
Min	0.52	0.51	0.51	0.50	0.49
Eff	25	25	17	17	18
Ø TE_{CRS}	0.71	0.71	0.68	0.68	0.67
σ	0.10	0.10	0.09	0.10	0.10
Min	0.45	0.49	0.49	0.49	0.46
Eff	12	13	6	7	6
Ø SE	0.96	0.96	0.96	0.96	0.95
σ	0.04	0.05	0.06	0.05	0.05
Min	0.71	0.60	0.59	0.50	0.50
Eff	12	13	6	7	6
Ø CE_{VRS}	0.71	0.71	0.70	0.69	0.68
σ	0.10	0.10	0.10	0.11	0.11
Min	0.51	0.50	0.48	0.49	0.48
Eff	13	14	12	12	14
Ø CE_{CRS}	0.68	0.69	0.68	0.67	0.65
σ	0.09	0.09	0.09	0.10	0.10
Min	0.42	0.46	0.48	0.48	0.45
Eff	4	8	5	7	5

Notes: TE = technical efficiency, SE = scale efficiency, CE = cost efficiency,
CRS/V RS = constant/variable returns to scale; Ø = mean,
σ = standard deviation, Min = minimum value;
Eff = number of efficient ('best practice') banks.

Table A.3: Results for value added approach – all savings banks

	2001 n = 433	2002 n = 435	2003 n = 435	2004 n = 435	2005 n = 435
Ø TE_{VRS}	0.78	0.76	0.74	0.76	0.75
σ	0.11	0.11	0.11	0.11	0.11
Min	0.50	0.51	0.51	0.56	0.54
Eff	36	31	24	29	27
Ø TE_{CRS}	0.75	0.73	0.72	0.73	0.73
σ	0.11	0.11	0.10	0.10	0.11
Min	0.49	0.50	0.53	0.52	0.52
Eff	17	17	15	17	18
Ø *SE*	0.96	0.96	0.96	0.96	0.96
σ	0.04	0.04	0.04	0.04	0.04
Min	0.68	0.71	0.71	0.71	0.70
Eff	17	17	15	17	18
Ø CE_{VRS}	0.69	0.67	0.64	0.65	0.64
σ	0.10	0.10	0.11	0.11	0.11
Min	0.50	0.47	0.44	0.44	0.45
Eff	11	8	7	9	8
Ø CE_{CRS}	0.65	0.63	0.59	0.59	0.59
σ	0.09	0.09	0.09	0.09	0.09
Min	0.46	0.45	0.42	0.40	0.40
Eff	4	5	4	4	3

Notes: TE = technical efficiency, SE = scale efficiency, CE = cost efficiency,
CRS/V RS = constant/variable returns to scale; Ø = mean,
σ = standard deviation, Min = minimum value;
Eff = number of efficient ('best practice') banks.

Table A.4: Results for intermediation approach – group of West German regions

	2001		2002		2003		2004		2005	
	n = 54		n = 54		n = 54		n = 54		n = 54	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Ø TE_{VRS}	0.76	0.88	0.76	0.89	0.74	0.89	0.74	0.89	0.75	0.90
σ	0.13	0.13	0.13	0.12	0.11	0.11	0.10	0.10	0.10	0.10
Min	0.50	0.56	0.51	0.61	0.54	0.63	0.56	0.68	0.57	0.67
Eff	4	16	3	20	1	18	2	17	2	16
Ø TE_{CRS}	0.75	0.85	0.74	0.86	0.72	0.86	0.73	0.86	0.74	0.88
σ	0.12	0.13	0.13	0.12	0.11	0.11	0.09	0.11	0.10	0.10
Min	0.49	0.55	0.51	0.60	0.54	0.63	0.55	0.67	0.56	0.66
Eff	2	11	2	13	1	9	1	10	2	8
Ø SE	0.98	0.96	0.97	0.96	0.97	0.97	0.98	0.97	0.99	0.98
σ	0.02	0.05	0.03	0.06	0.03	0.05	0.03	0.04	0.02	0.03
Min	0.92	0.76	0.88	0.72	0.85	0.80	0.84	0.82	0.88	0.83
Eff	2	11	2	13	1	9	1	10	2	8
Ø CE_{VRS}	0.69	0.81	0.67	0.80	0.65	0.83	0.63	0.80	0.64	0.79
σ	0.11	0.14	0.12	0.14	0.11	0.13	0.10	0.13	0.10	0.14
Min	0.48	0.53	0.47	0.53	0.46	0.57	0.46	0.53	0.46	0.50
Eff	0	10	1	10	1	11	0	7	1	7
Ø CE_{CRS}	0.64	0.75	0.63	0.74	0.59	0.77	0.56	0.69	0.59	0.65
σ	0.10	0.12	0.12	0.13	0.12	0.12	0.11	0.12	0.10	0.11
Min	0.46	0.53	0.46	0.53	0.39	0.51	0.38	0.48	0.42	0.44
Eff	0	3	1	5	1	5	0	3	1	2
Ø RE_{VRS}	0.77	0.93	0.76	0.92	0.74	0.92	0.74	0.92	0.76	0.94
σ	0.12	0.07	0.13	0.09	0.11	0.08	0.09	0.08	0.10	0.07
Min	0.54	0.76	0.53	0.75	0.54	0.71	0.59	0.73	0.59	0.76
Eff	4	17	3	18	1	19	2	18	2	19
Ø RE_{CRS}	0.75	0.90	0.74	0.90	0.72	0.90	0.73	0.90	0.74	0.92
σ	0.12	0.08	0.13	0.09	0.11	0.08	0.09	0.08	0.10	0.07
Min	0.53	0.75	0.51	0.73	0.54	0.71	0.59	0.72	0.58	0.76
Eff	2	11	2	15	1	10	1	11	2	12

Notes: (1) values based on analysis of whole sample, (2) values based on analysis of savings banks in West Germany; TE = technical efficiency, SE = scale efficiency, CE = cost efficiency, RE = revenue efficiency; CRS/V RS = constant/variable returns to scale; Ø = mean, σ = standard deviation, Min = minimum value; Eff = number of efficient ('best practice') banks.

Table A.5: Results for intermediation approach – group of East German regions

	2001		2002		2003		2004		2005	
	n = 379		n = 381		n = 381		n = 381		n = 381	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Ø TE_{VRS}	0.78	0.78	0.75	0.75	0.72	0.72	0.74	0.74	0.74	0.74
σ	0.12	0.12	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Min	0.54	0.54	0.52	0.52	0.49	0.49	0.47	0.47	0.48	0.48
Eff	30	31	26	28	19	23	26	26	24	24
Ø TE_{CRS}	0.76	0.76	0.72	0.72	0.69	0.69	0.71	0.71	0.71	0.72
σ	0.12	0.12	0.12	0.13	0.12	0.12	0.12	0.12	0.12	0.12
Min	0.47	0.47	0.38	0.38	0.37	0.37	0.41	0.41	0.42	0.42
Eff	15	17	15	17	9	13	14	14	16	16
Ø SE	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.97	0.97
σ	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.05	0.05
Min	0.69	0.69	0.66	0.66	0.63	0.63	0.63	0.63	0.63	0.63
Eff	15	17	15	17	9	13	14	15	16	16
Ø CE_{VRS}	0.68	0.68	0.64	0.64	0.62	0.62	0.62	0.62	0.61	0.62
σ	0.11	0.11	0.11	0.11	0.12	0.12	0.13	0.13	0.13	0.13
Min	0.45	0.45	0.45	0.45	0.39	0.39	0.38	0.38	0.39	0.39
Eff	9	9	6	6	7	7	9	9	8	8
Ø CE_{CRS}	0.63	0.63	0.59	0.59	0.56	0.56	0.56	0.56	0.56	0.56
σ	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.12
Min	0.42	0.42	0.35	0.35	0.30	0.30	0.29	0.29	0.29	0.29
Eff	4	4	4	4	3	3	4	4	4	4
Ø RE_{VRS}	0.79	0.79	0.77	0.77	0.75	0.76	0.77	0.77	0.76	0.76
σ	0.12	0.12	0.12	0.12	0.11	0.12	0.11	0.11	0.12	0.12
Min	0.54	0.54	0.53	0.53	0.54	0.54	0.53	0.53	0.54	0.54
Eff	32	34	28	30	23	26	27	27	25	25
Ø RE_{CRS}	0.76	0.76	0.74	0.75	0.72	0.73	0.74	0.74	0.73	0.73
σ	0.11	0.11	0.11	0.11	0.10	0.11	0.11	0.11	0.11	0.11
Min	0.49	0.49	0.50	0.50	0.53	0.53	0.53	0.53	0.53	0.53
Eff	15	17	15	17	14	16	16	16	16	17

Notes: (1) values based on analysis of whole sample, (2) values based on analysis of savings banks in East Germany; TE = technical efficiency, SE = scale efficiency, CE = cost efficiency, RE = revenue efficiency; CRS/V RS = constant/variable returns to scale; Ø = mean, σ = standard deviation, Min = minimum value; Eff = number of efficient ('best practice') banks.

Table A.6: Results for intermediation approach - group of less densely populated regions

	2001		2002		2003		2004		2005	
	n = 212		n = 214		n = 214		n = 214		n = 214	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Ø TE_{VRS}	0.75	0.84	0.72	0.84	0.70	0.84	0.71	0.84	0.71	0.81
σ	0.12	0.11	0.13	0.11	0.12	0.11	0.12	0.11	0.12	0.12
Min	0.54	0.57	0.52	0.58	0.49	0.61	0.47	0.58	0.48	0.58
Eff	14	31	12	35	7	39	8	39	9	29
Ø TE_{CRS}	0.73	0.82	0.69	0.83	0.67	0.81	0.68	0.81	0.69	0.79
σ	0.11	0.11	0.12	0.11	0.12	0.11	0.11	0.11	0.11	0.11
Min	0.50	0.57	0.47	0.58	0.46	0.57	0.46	0.54	0.48	0.57
Eff	6	22	7	27	3	20	4	15	6	14
Ø SE	0.97	0.97	0.96	0.98	0.96	0.97	0.97	0.97	0.97	0.97
σ	0.04	0.03	0.05	0.03	0.06	0.04	0.06	0.05	0.05	0.04
Min	0.69	0.70	0.66	0.75	0.64	0.75	0.66	0.72	0.70	0.74
Eff	6	22	7	27	3	20	4	15	6	14
Ø CE_{VRS}	0.66	0.78	0.62	0.76	0.60	0.78	0.59	0.75	0.59	0.72
σ	0.11	0.12	0.11	0.12	0.11	0.12	0.12	0.13	0.12	0.13
Min	0.45	0.53	0.45	0.53	0.39	0.54	0.38	0.48	0.39	0.48
Eff	2	19	1	17	3	16	2	16	3	10
Ø CE_{CRS}	0.61	0.76	0.57	0.74	0.54	0.76	0.53	0.71	0.53	0.69
σ	0.09	0.12	0.09	0.12	0.09	0.11	0.09	0.12	0.10	0.12
Min	0.43	0.52	0.40	0.53	0.36	0.54	0.35	0.48	0.35	0.47
Eff	0	10	1	9	1	7	0	5	1	4
Ø RE_{VRS}	0.76	0.85	0.74	0.86	0.72	0.85	0.73	0.85	0.73	0.83
σ	0.11	0.10	0.12	0.10	0.11	0.10	0.10	0.10	0.11	0.11
Min	0.54	0.60	0.54	0.66	0.54	0.61	0.57	0.63	0.54	0.62
Eff	14	31	14	35	9	38	9	35	9	28
Ø RE_{CRS}	0.73	0.83	0.72	0.84	0.70	0.81	0.71	0.82	0.71	0.80
σ	0.11	0.10	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Min	0.53	0.59	0.54	0.64	0.54	0.61	0.56	0.62	0.54	0.60
Eff	6	19	7	24	7	16	7	17	7	11

Notes: (1) values based on analysis of whole sample, (2) values based on analysis of savings banks in less densely populated regions, i.e. regions with population density ≤ median (2001); TE = technical efficiency, SE = scale efficiency, CE = cost efficiency, RE = revenue efficiency;
CRS/V RS = constant/variable returns to scale; Ø = mean, σ = standard deviation, Min = minimum value; Eff = number of efficient ('best practice') banks.

Table A.7: Results for intermediation approach - group of densely populated regions

	2001		2002		2003		2004		2005	
	n = 213		n = 213		n = 213		n = 213		n = 213	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Ø TE_{VRS}	0.80	0.84	0.77	0.81	0.75	0.79	0.77	0.80	0.77	0.80
σ	0.12	0.11	0.13	0.12	0.13	0.12	0.13	0.13	0.13	0.13
Min	0.50	0.57	0.51	0.57	0.50	0.51	0.49	0.49	0.48	0.48
Eff	18	31	16	22	12	20	19	21	16	23
Ø TE_{CRS}	0.77	0.82	0.74	0.79	0.71	0.75	0.74	0.75	0.74	0.77
σ	0.12	0.11	0.12	0.11	0.12	0.12	0.12	0.12	0.12	0.13
Min	0.47	0.52	0.38	0.47	0.37	0.42	0.41	0.41	0.42	0.42
Eff	9	16	9	13	6	9	10	11	11	15
Ø SE	0.97	0.98	0.96	0.98	0.96	0.95	0.96	0.94	0.97	0.97
σ	0.04	0.04	0.05	0.04	0.06	0.05	0.05	0.06	0.05	0.05
Min	0.69	0.78	0.67	0.78	0.63	0.67	0.63	0.62	0.63	0.65
Eff	9	16	9	13	6	9	10	11	11	15
Ø CE_{VRS}	0.70	0.70	0.66	0.66	0.64	0.64	0.64	0.65	0.64	0.65
σ	0.11	0.11	0.12	0.12	0.12	0.12	0.13	0.13	0.13	0.13
Min	0.48	0.48	0.46	0.46	0.43	0.43	0.43	0.43	0.41	0.41
Eff	7	7	6	6	5	5	7	7	6	6
Ø CE_{CRS}	0.66	0.66	0.62	0.62	0.59	0.59	0.59	0.59	0.59	0.60
σ	0.10	0.10	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.12
Min	0.42	0.42	0.35	0.35	0.30	0.30	0.29	0.29	0.29	0.29
Eff	4	4	4	4	3	3	4	4	4	4
Ø RE_{VRS}	0.81	0.86	0.80	0.84	0.78	0.82	0.80	0.84	0.79	0.82
σ	0.11	0.10	0.11	0.10	0.11	0.11	0.11	0.11	0.11	0.11
Min	0.55	0.60	0.53	0.57	0.54	0.59	0.53	0.60	0.54	0.55
Eff	20	30	16	21	0.14	22	19	25	17	25
Ø RE_{CRS}	0.78	0.84	0.77	0.82	0.74	0.79	0.76	0.79	0.76	0.79
σ	0.11	0.09	0.11	0.10	0.10	0.10	0.11	0.10	0.11	0.11
Min	0.49	0.58	0.50	0.54	0.53	0.56	0.53	0.57	0.53	0.55
Eff	9	17	9	14	7	10	9	12	10	16

Notes: (1) values based on analysis of whole sample, (2) values based on analysis of savings banks in densely populated regions, i.e. regions with population density > median (2001); TE = technical efficiency, SE = scale efficiency, CE = cost efficiency, RE = revenue efficiency;
CRS/V RS = constant/variable returns to scale; Ø = mean, σ = standard deviation, Min = minimum value; Eff = number of efficient ('best practice') banks.

Table A.8: Results for intermediation approach - group of economically weak regions

	2001		2002		2003		2004		2005	
	n = 216		n = 218		n = 218		n = 218		n = 218	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Ø TE_{VRS}	0.76	0.85	0.73	0.85	0.71	0.85	0.72	0.84	0.73	0.83
σ	0.12	0.11	0.12	0.11	0.12	0.11	0.12	0.11	0.12	0.12
Min	0.50	0.54	0.51	0.58	0.50	0.62	0.47	0.59	0.48	0.59
Eff	14	38	11	36	7	44	10	37	9	37
Ø TE_{CRS}	0.74	0.83	0.70	0.84	0.68	0.82	0.70	0.81	0.70	0.80
σ	0.11	0.11	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Min	0.49	0.53	0.47	0.58	0.46	0.56	0.46	0.54	0.48	0.57
Eff	6	24	6	25	3	22	5	15	6	21
Ø SE	0.97	0.98	0.96	0.98	0.96	0.97	0.97	0.97	0.97	0.97
σ	0.05	0.03	0.05	0.03	0.06	0.04	0.06	0.05	0.05	0.04
Min	0.69	0.75	0.67	0.81	0.63	0.75	0.63	0.72	0.63	0.72
Eff	6	24	6	25	3	22	5	15	6	21
Ø CE_{VRS}	0.67	0.80	0.63	0.78	0.61	0.77	0.60	0.74	0.60	0.71
σ	0.11	0.12	0.11	0.12	0.12	0.12	0.12	0.13	0.12	0.13
Min	0.45	0.53	0.45	0.53	0.39	0.52	0.38	0.47	0.39	0.47
Eff	3	20	2	16	3	18	2	16	3	11
Ø CE_{CRS}	0.61	0.78	0.58	0.75	0.55	0.75	0.54	0.70	0.54	0.68
σ	0.09	0.11	0.09	0.11	0.09	0.11	0.09	0.12	0.10	0.12
Min	0.43	0.52	0.40	0.53	0.36	0.51	0.35	0.47	0.35	0.44
Eff	0	9	1	9	1	9	0	7	1	5
Ø RE_{VRS}	0.77	0.85	0.75	0.87	0.73	0.86	0.75	0.85	0.74	0.83
σ	0.12	0.10	0.12	0.10	0.11	0.10	0.11	0.10	0.11	0.11
Min	0.54	0.61	0.53	0.65	0.54	0.61	0.57	0.63	0.56	0.63
Eff	16	37	13	35	9	45	11	33	10	35
Ø RE_{CRS}	0.74	0.83	0.73	0.85	0.71	0.83	0.72	0.82	0.72	0.81
σ	0.11	0.10	0.11	0.09	0.10	0.10	0.10	0.10	0.11	0.11
Min	0.53	0.60	0.51	0.64	0.54	0.61	0.56	0.62	0.55	0.60
Eff	7	20	7	24	6	15	7	13	6	14

Notes: (1) values based on analysis of whole sample, (2) values based on analysis of savings banks in economically weak regions, i.e. regions with purchasing power per inhabitant ≤ median (2001); TE = technical efficiency, SE = scale efficiency, CE = cost efficiency, RE = revenue efficiency; CRS/V RS = constant/variable returns to scale; Ø = mean, σ = standard deviation, Min = minimum value; Eff = number of efficient ('best practice') banks.

Table A.9: Results for intermediation approach - group of economically powerful regions

	2001		2002		2003		2004		2005	
	n = 217		n = 217		n = 217		n = 217		n = 217	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Ø TE_{VRS}	0.80	0.81	0.77	0.78	0.74	0.75	0.76	0.77	0.76	0.77
σ	0.12	0.12	0.13	0.14	0.13	0.14	0.13	0.13	0.13	0.13
Min	0.57	0.57	0.53	0.53	0.49	0.52	0.51	0.52	0.52	0.54
Eff	20	24	18	19	13	16	18	19	17	21
Ø TE_{CRS}	0.77	0.77	0.74	0.74	0.71	0.71	0.73	0.73	0.73	0.74
σ	0.12	0.12	0.13	0.13	0.13	0.13	0.12	0.13	0.13	0.13
Min	0.47	0.47	0.38	0.38	0.37	0.37	0.41	0.41	0.42	0.42
Eff	11	12	11	13	7	9	10	10	12	14
Ø SE	0.97	0.96	0.96	0.95	0.96	0.95	0.96	0.96	0.97	0.96
σ	0.04	0.05	0.05	0.07	0.06	0.07	0.05	0.06	0.05	0.06
Min	0.69	0.58	0.66	0.56	0.64	0.56	0.69	0.62	0.70	0.65
Eff	11	12	11	13	7	9	10	10	12	14
Ø CE_{VRS}	0.70	0.71	0.66	0.68	0.63	0.66	0.64	0.65	0.63	0.66
σ	0.11	0.12	0.12	0.13	0.12	0.13	0.13	0.14	0.13	0.14
Min	0.49	0.49	0.46	0.47	0.45	0.46	0.44	0.44	0.42	0.44
Eff	6	8	5	8	5	7	7	8	6	7
Ø CE_{CRS}	0.65	0.65	0.61	0.61	0.58	0.58	0.58	0.58	0.58	0.59
σ	0.10	0.10	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.12
Min	0.42	0.42	0.35	0.35	0.30	0.30	0.29	0.29	0.29	0.29
Eff	4	4	4	4	3	3	4	4	4	4
Ø RE_{VRS}	0.80	0.81	0.79	0.80	0.77	0.79	0.79	0.80	0.78	0.79
σ	0.11	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.12	0.12
Min	0.55	0.59	0.53	0.56	0.54	0.58	0.53	0.58	0.54	0.56
Eff	20	24	18	19	15	18	18	21	17	21
Ø RE_{CRS}	0.77	0.78	0.76	0.76	0.74	0.75	0.75	0.77	0.75	0.76
σ	0.11	0.11	0.11	0.12	0.11	0.11	0.11	0.11	0.12	0.12
Min	0.49	0.49	0.50	0.50	0.53	0.54	0.53	0.56	0.53	0.55
Eff	10	12	10	12	9	10	10	12	12	15

Notes: (1) values based on analysis of whole sample, (2) values based on analysis of savings banks in economically powerful regions, i.e. regions with purchasing power per inhabitant > median (2001); TE = technical efficiency, SE = scale efficiency, CE = cost efficiency, RE = revenue efficiency; CRS/V RS = constant/variable returns to scale; Ø = mean, σ = standard deviation, Min = minimum value; Eff = number of efficient ('best practice') banks.

Table A.10: Results for intermediation approach - group of declining regions

	2001		2002		2003		2004		2005	
	n = 234		n = 235		n = 235		n = 235		n = 235	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Ø TE_{VRS}	0.77	0.83	0.74	0.83	0.72	0.82	0.74	0.81	0.74	0.79
σ	0.12	0.11	0.12	0.11	0.12	0.11	0.12	0.12	0.12	0.12
Min	0.50	0.54	0.51	0.58	0.50	0.61	0.47	0.58	0.48	0.55
Eff	17	38	13	36	8	31	13	34	12	28
Ø TE_{CRS}	0.75	0.81	0.71	0.79	0.69	0.78	0.71	0.76	0.71	0.76
σ	0.11	0.12	0.11	0.11	0.11	0.12	0.12	0.12	0.12	
Min	0.49	0.53	0.47	0.58	0.46	0.52	0.46	0.54	0.48	0.52
Eff	8	28	8	21	4	20	8	19	8	18
Ø *SE*	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.94	0.97	0.95
σ	0.05	0.04	0.05	0.05	0.06	0.05	0.06	0.06	0.05	0.05
Min	0.69	0.74	0.66	0.73	0.63	0.69	0.63	0.65	0.63	0.66
Eff	8	28	8	21	4	20	8	19	8	18
Ø CE_{VRS}	0.68	0.76	0.64	0.76	0.62	0.77	0.62	0.73	0.62	0.70
σ	0.10	0.11	0.10	0.11	0.11	0.11	0.12	0.12	0.12	0.13
Min	0.45	0.49	0.45	0.54	0.39	0.51	0.38	0.46	0.39	0.46
Eff	3	13	1	13	2	17	2	13	4	8
Ø CE_{CRS}	0.62	0.72	0.59	0.73	0.56	0.74	0.55	0.70	0.55	0.67
σ	0.09	0.11	0.09	0.11	0.09	0.11	0.10	0.12	0.10	0.12
Min	0.43	0.48	0.41	0.53	0.36	0.50	0.35	0.46	0.35	0.44
Eff	0	6	0	5	0	10	0	6	1	5
Ø RE_{VRS}	0.77	0.85	0.76	0.85	0.74	0.84	0.76	0.83	0.76	0.81
σ	0.11	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Min	0.54	0.60	0.53	0.62	0.54	0.62	0.57	0.62	0.56	0.62
Eff	17	42	13	41	9	35	13	37	12	27
Ø RE_{CRS}	0.75	0.83	0.73	0.82	0.72	0.81	0.73	0.78	0.73	0.78
σ	0.11	0.10	0.11	0.10	0.10	0.11	0.10	0.11	0.11	0.11
Min	0.53	0.59	0.51	0.61	0.54	0.61	0.56	0.61	0.55	0.60
Eff	6	26	6	17	4	18	8	16	9	13

Notes: (1) values based on analysis of whole sample, (2) values based on analysis of savings banks in declining regions, i.e. regions with declining population in 2001-2025; TE = technical efficiency, SE = scale efficiency, CE = cost efficiency, RE = revenue efficiency; CRS/V RS = constant/variable returns to scale; Ø = mean, σ = standard deviation, Min = minimum value; Eff = number of efficient ('best practice') banks.

Table A.11: Results for intermediation approach - group of growing regions

	2001		2002		2003		2004		2005	
	n = 191		n = 192		n = 192		n = 192		n = 192	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Ø TE_{VRS}	0.78	0.83	0.75	0.82	0.72	0.80	0.74	0.81	0.74	0.80
σ	0.12	0.12	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Min	0.55	0.57	0.52	0.53	0.49	0.51	0.51	0.54	0.51	0.53
Eff	15	29	15	25	11	25	14	26	13	24
Ø TE_{CRS}	0.76	0.81	0.72	0.80	0.69	0.77	0.71	0.79	0.72	0.77
σ	0.12	0.11	0.13	0.12	0.12	0.13	0.12	0.12	0.13	0.13
Min	0.47	0.53	0.38	0.48	0.37	0.44	0.41	0.49	0.42	0.45
Eff	7	14	8	15	5	11	6	13	9	14
Ø SE	0.97	0.98	0.96	0.98	0.96	0.97	0.97	0.98	0.97	0.97
σ	0.04	0.03	0.05	0.04	0.05	0.04	0.05	0.04	0.04	0.05
Min	0.77	0.71	0.70	0.63	0.68	0.60	0.69	0.57	0.70	0.56
Eff	7	14	8	15	5	11	6	13	9	14
Ø CE_{VRS}	0.69	0.69	0.65	0.66	0.62	0.63	0.62	0.63	0.62	0.64
σ	0.12	0.12	0.13	0.14	0.13	0.14	0.14	0.14	0.13	0.14
Min	0.49	0.49	0.46	0.46	0.40	0.41	0.39	0.39	0.41	0.42
Eff	6	9	6	11	6	8	7	11	5	9
Ø CE_{CRS}	0.64	0.64	0.60	0.60	0.57	0.57	0.57	0.57	0.57	0.57
σ	0.11	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Min	0.42	0.42	0.35	0.35	0.30	0.30	0.29	0.29	0.29	0.29
Eff	4	4	5	5	4	4	4	4	4	4
Ø RE_{VRS}	0.79	0.86	0.78	0.85	0.76	0.83	0.77	0.83	0.77	0.82
σ	0.12	0.10	0.12	0.11	0.12	0.11	0.12	0.11	0.12	0.11
Min	0.55	0.60	0.53	0.57	0.54	0.55	0.53	0.56	0.54	0.55
Eff	17	32	17	27	14	23	15	26	14	24
Ø RE_{CRS}	0.76	0.84	0.75	0.83	0.73	0.80	0.74	0.81	0.74	0.79
σ	0.11	0.10	0.11	0.10	0.11	0.11	0.11	0.11	0.12	0.11
Min	0.49	0.59	0.50	0.56	0.53	0.54	0.53	0.54	0.53	0.54
Eff	9	14	10	17	10	12	8	15	8	14

Notes: (1) values based on analysis of whole sample, (2) values based on analysis of savings banks in growing regions, i.e. regions with growing population in 2001-2025; TE = technical efficiency, SE = scale efficiency, CE = cost efficiency, RE = revenue efficiency; CRS/V RS = constant/variable returns to scale; Ø = mean, σ = standard deviation, Min = minimum value; Eff = number of efficient ('best practice') banks.