The Transition to the Single Market in the German Insurance Industry

March, 2000

Bernhard Mahlberg
Vienna University of Economics and Business Administration
Research Institute for European Affairs
e-mail: Bernhard.Mahlberg@wu-wien.ac.at

Thomas Url
Austrian Institute of Economic Research
e-mail: url@wsr.ac.at

Abstract
The Single Market Project of the European Commission was supposed to change the financial service industry markedly. We provide a first attempt to assess its consequences on the insurance industry in Germany, the largest insurance market within the European Union. For this purpose we apply a Data Envelopment Analysis on a panel of German insurance companies and compute efficiency scores for the years 1992 through 1996 as well as a Malmquist index for the productivity growth. The results indicate cost saving potentials and an increasing divergence between fully efficient firms and efficiency laggards. Measured scale economies imply an L-shaped average cost curve for the industry and thus low cost saving potential from further merging activities.

Keywords: European Integration, Single Market, Productivity growth
JEL-classification: L50, G22, C14

The authors gratefully acknowledge valuable comments on earlier versions from Peter Albrecht, Walter Karten, Günter Lang, Mikulas Luptacik, Michael Theil, Peter Welzel, Georg Winckler, and seminar participants at the Universities of Augsburg, Mannheim, and Vienna. Ursula Glauninger provided valuable research assistance. The usual disclaimer applies.

Introduction

The Single Market program of the European Commission changed the landscape for financial services significantly. Especially so within the insurance industry. Before 1994, national markets were closed to direct cross-border selling activities and heavy regulation of insurance contracts limited competition among firms to differences in their quality of services, rather than the content or price of insurance. After the introduction of several insurance directives between 1987 and 1994 insurance companies are now free to design their products and to operate throughout the European Economic Area under a single license and prudential control. This new set of regulatory rules was expected to transform the insurance industry into a more competitive market, to increase productivity by creating new and more diversified products, to change distribution channels, and to increase merging activities (Swiss Re, 1996). From a consumer perspective lower premiums were eventually expected to emerge.

After six years of the Single Market we can conclude that a low degree of foreign penetration still prevails throughout Europe. The insurance industry, however, markedly adapted to the new conditions. This can be shown by the developments on the German insurance market, which is the largest within the European Union. One of the most obvious developments in the German insurance market was the reduction of premiums in the automobile insurance. Contracts in this branch usually mature after one to three years, which is why renewal rates are high. Due to their compulsory character they provide a foundation for customer relations that can broaden to include alternative insurance products. Consequently, a fierce competition has emerged around rebates since 1994. This response to the challenges of the Single Market reduces expected revenues for both incumbents and new entrants. Profit margins will fall due to this strategy and thus firms are forced to improve their cost structure. As a counter strategy deeper product differentiation helps to stabilize margins and creates a multiplicity of product characteristics, which increase the costs of information collection for consumers.

This environment puts pressure on less efficient firms to improve productivity and assess their position relative to the market. The measurement of efficiency in the insurance industry is, however, disputed (Kessler, 1991). We choose a measure which is based on a consumer's perspective and use the framework of a Data Envelopment Analysis (DEA) to get estimates for the efficiency of individual insurance companies with respect to benchmark firms (Cummins and Weiss, 1998). Our measure should be distinguished from a pure shareholder value perspective, which would focus on factors like the return on investment, the dividend yield or similar indices in order to analyze the productivity of companies.

We will use a panel of German insurance companies over the period 1992 through 1996. The results of the DEA will allow us to assess the technical efficiency of individual firms with regard to a set of best practice or benchmark firms. Furthermore, we will be able to decompose technical inefficiency into pure technical inefficiency and scale inefficiency. This will give us an idea of likely benefits from future merger activities in the German insurance industry. Our measure also allows us to track the productivity development over time and thus to get an impression of the dynamic consequences of the Single Market project. Certainly other factors like the German unification, financial innovation, and general technological progress exert an impact on the insurance industry, thus creating a degree of uncertainty about how much of the productivity development can be attributed to the Single Market project.

Our paper is organized as follows. In the first section we provide a short overview on the German insurance market. Then we briefly describe the theoretical background for efficiency measurement and the linear programming method (DEA). In section four we discuss our choice of inputs and outputs and present the data. The next section presents empirical results, and finally we summarize our findings and conclude.

The German Insurance Market

Measured by total premium income the German insurance market ranks as the biggest within the European Union and as one of the largest among industrialized countries. In life insurance the amount of written premium ranks third within the EU and fifth among industrialized countries. The non-life sector is the largest in the EU and second only in the OECD (cf. Table 1). Due to the high income replacement ratio in the public pension system the life insurance business is rather low. For this reason the average per capita premium (density) as well as the premium to GDP ratio (insurance penetration) are comparatively low. Foreign penetration through branches and free provision of services still plays a minor role: about 2.1 percent of premium income in Germany are generated in this way. Since the beginning of the Single Market program in 1994 this share has decreased by roughly one percentage point. This does not imply that the Single Market has failed, because foreign firms may acquire existing German companies or set up subsidiaries that operate under German prudential control. In 1996 an additional 9.1 percent of premium income was written by firms under foreign control.

Table 1: *Top 10 world insurance markets*

Country	Premium income Total	Life	Non-life	Total market share	Penetration	Density
	Mill. USD			Percent		USD per inhabitant
USA	795,115	315,538	479,577	38.5	9.9	2,739
Japan	376,642	269,843	106,799	19.6	8.0	2,937
Germany	196,952	72,215	124,737	8.2	6.6	1,901
France	149,288	93,226	56,062	7.4	9.1	2,393
United Kingdom	148,568	86,883	61,685	7.4	12.1	2,366
Korea	63,813	46,351	17,462	3.3	12.9	1,367
Italy	48,248	18,640	29,608	2.3	3.6	752
Switzerland	38,967	22,828	16,138	1.8	11.2	4,642
Netherlands	37,120	20,041	17,079	1.9	9.1	2,330
Australia	32,631	16,073	16,558	1.6	7.8	1,658
EU15	692,479	346,074	346,405	32.8	7.2	1,663
OECD	2,050,698	1,035,211	1,015,487	100.0	8.1	1,731

S:OECD.

The German insurance law distinguishes three lines of business: life, health, and property liability insurance. Companies are required to establish separate legal entities and consequently to run separate book accounts for these three lines. Within the German market property liability insurance is the most important line, accounting for about 45 percent of premiums in 1996. The life insurance accounts for around 39 percent of premium income. The portion of the property liability business has been slightly decreasing over the last few years, that of health insurance slightly increasing, whereas life insurance business has stagnated (Federal Supervisory Agency, 1997).

A short overview of the structure of the German insurance market is provided in Table 2. 444 companies operated in 1996. The number of firms has been decreasing since the beginning of the European Single Market in 1994. Most of the firms underwrite property liability insurance. Health insurance forms the smallest line of business. The majority of the companies operate as stock companies although mutuals are also a popular organizational form. Additionally, foreign companies and firms owned by public authorities participate in the market. Market concentration is highest in health insurance and lowest in the property liability business. The concentration ratio has decreased slightly over the last few years (cf. Table 2).

Table 2: *Structure of the German insurance market, 1990 to 1996*

	1990	1991	1992	1993	1994	1995	1996
				Number of companies[1])			
Lines of business							
Total	488	504	508	490	450	465	444
Life	109	114	116	121	120	125	121
Health	55	61	61	58	56	61	57
Property liability	324	329	331	311	274	279	266
Organizational form							
Mutuals	138	137	133	132	125	--	--
Foreign	83	82	81	76	30	--	--
Stock	253	271	280	269	282	--	--
Public	14	14	14	13	13	--	--
				Billion DM			
Gross premiums written							
Total	134	155	171	196	213	227	234
Life	53	61	67	76	83	89	93
Health	18	20	22	26	28	32	34
Property liability	63	75	82	94	102	106	107
				In percent of total premium income			
Market share of the top five companies							
Life	33.0	32.0	31.6	31.0	30.7	30.7	30.3
Health	56.4	55.7	54.8	52.5	52.3	51.2	50.8
Property liability	26.2	24.9	24.4	22.8	23.0	22.7	23.0

S: *Rehnert* (1997), *Federal Supervisory Agency* (1997). - [1]) Under federal supervision, without pure reinsurers, specialized transport insurance, and pension funds.

In the beginning of the 1990s deregulation measures were applied to the German insurance industry in preparation of joining the Single Market. Although the deregulation phase started as early as 1987 with the establishment of the European Union (EU) Solvency Rules it took until the beginning of 1994 for all of the three EU-directives on insurance to be fully implemented.

Since 1994 insurance companies have been free to open up branches and provide services under a single license and prudential control. At the same time German firms experienced a tremendous increase in their domestic market size due to the German unification. Starting in the middle of 1990 West German companies entered the East German insurance market. They were confronted with an even more biased insurance structure than in their home country. Life and health insurance policies were almost negligible, as were some of the property and liability policies. Only basic household and motor third party insurance policies were popular (Wagner, 1991). Within the first years of unification distribution channels and new administration layers had to be build in the East (Klein, 1991). These actives laid the foundation for a rapid growth in premium income from Eastern Germany during the first half of the 90's.

The Measurement of Efficiency and Technical Progress

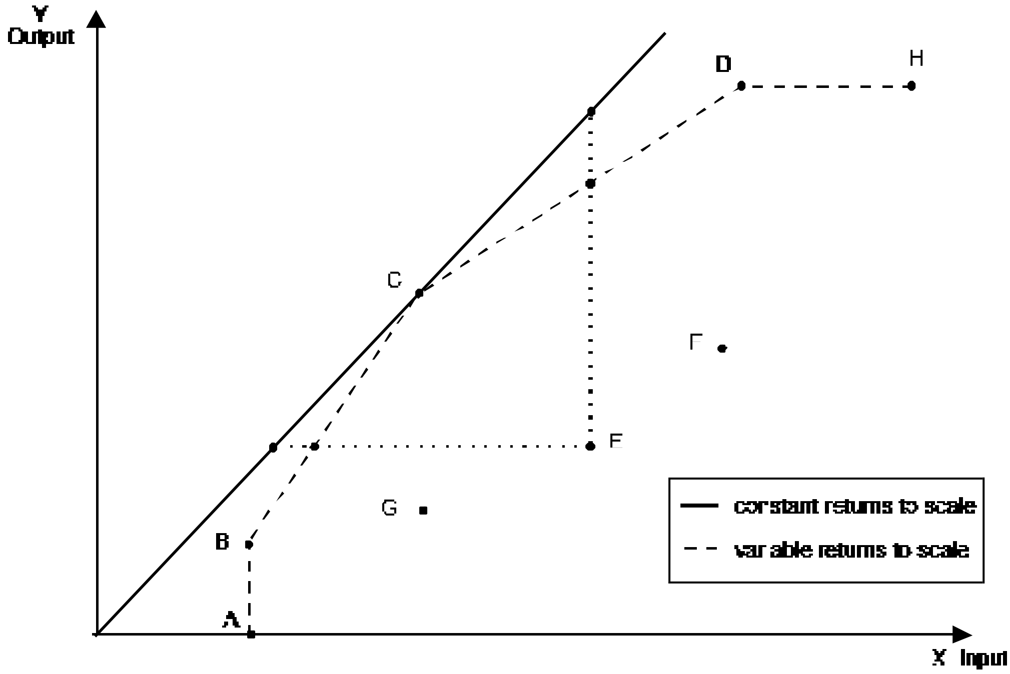
For measuring the level and dynamics of firm specific productivity several concepts of efficiency can be used. The most common measure is cost efficiency, which suggests that profit-maximizing behavior drives firms to choose a combination of inputs such that the costs of producing a given level of output are minimized. Other measures are revenue and profit efficiency. In contrast to these concepts technical efficiency ignores input and output prices and thus only looks for input-output-combinations that are efficient with respect to a given technology, i.e. no inputs are wasted. Sheldon and Haegler (1993) provide a comprehensive explanation. Because data on input prices are not available for Germany we will confine ourselves to the measurement of technical efficiency.

The basic problem with measuring the productive efficiency of micro units such as insurance companies is to establish a benchmark that can be used as a reference point to compare the performance of individual companies with. Additionally, inputs in the insurance industry are often used in a joint production process where the same input contributes simultaneously to several lines of business. For example, the property liability business is fundamentally different from life insurance, nevertheless, it may share the same marketing or data processing facilities as well as distribution channels.

For modeling joint production processes Farrell (1957) introduced the concept of the efficiency frontier, which delineates the technological limits of what a firm can achieve with a given level of inputs. This frontier allows us to classify firms as technically efficient units if they provide a benchmark for the rest of the industry. In contrast to that, an inefficient firm could either produce more with the available inputs (output oriented efficiency) or decrease the use of inputs while keeping production unchanged (input oriented efficiency). The indicator of inefficiency is then given by the relative distance between the input-output-combination of a firm and the nearest benchmark.

To estimate this indicator of efficiency for individual companies we apply a Data Envelopment Analysis (DEA) developed by Charnes, Cooper and Rhodes (1978). This is a non-parametric approach that uses a linear programming technique to construct an envelope for the observed input-output combinations of all market participants under the constraint that only best practice firms support the envelope. Specifically for the insurance industry Cummins and Weiss (1998) present the pros and cons of the DEA approach and alternative methods like stochastic frontier analysis.

Figure 1: *Efficiency frontiers under constant and variable returns to scale*



We choose two different assumptions on the production technology. The first one allows for variable returns to scale (VRS) and thus permits the coexistence of economies and diseconomies of scale. An envelope, which fulfills this condition for the one input/one output case, is shown as the dashed curve in Figure 1. The second assumption relaxes the convexity constraint and efficiency is measured under the assumption of constant returns to scale (CRS). The solid line in Figure 1 shows an envelope that fulfills this condition. The computation of the envelope can be reduced to a linear program for each individual firm in which the following optimization problem is solved:

$$\min q_0$$

$$\text{s.t.} \quad \sum_j y_{rj} l_j \geq y_{r0}, \; q_0 x_{i0} - \sum_j x_{ij} l_j \geq 0 \quad q_0 \textit{ free}, \; l_j ³0,$$

$$\sum_j l_j = 1 \qquad \textit{(in case of VRS)},$$

$$\sum_j l_j = \textit{free} \quad \textit{(in case of CRS)}$$

where q_0 is the efficiency score of the firm under investigation. The index j indicates individual firms for $j = 1,...,N$. y_{rj} is the r-th output of the j-th firm for $r = 1,...,R$. x_{ij} represents the i-th input of the j-th firm for $i = 1,...,I$. l_j is the weight of the j-th firm in the minimization problem. This procedure minimizes the efficiency score q_0 of a single firm and must be repeated for every firm in the sample. In this study we measure input oriented efficiency. This allows us to compute the potential cost savings in the German insurance industry.

The difference between the solid and dashed envelopes in Figure 1 can be used to infer advantages or disadvantages of size in the insurance industry. Economies of scale exist if an increase in all inputs by the same positive constant $m>1$ raises the production level by more than m. Constant returns to scale prevail if the growth in inputs exactly matches the increase in the output level. Decreasing returns to scale emerge when the output response is less than proportional. The economic intuition of scale economies is related to the behavior of average costs: if scale economies exist, average costs decrease with a growing level of output. If the applied technology implies a U-shaped average cost curve an optimal firm size exists within an industry. Going beyond this production level would bring a firm into the range of decreasing returns to scale or increasing average costs, respectively.

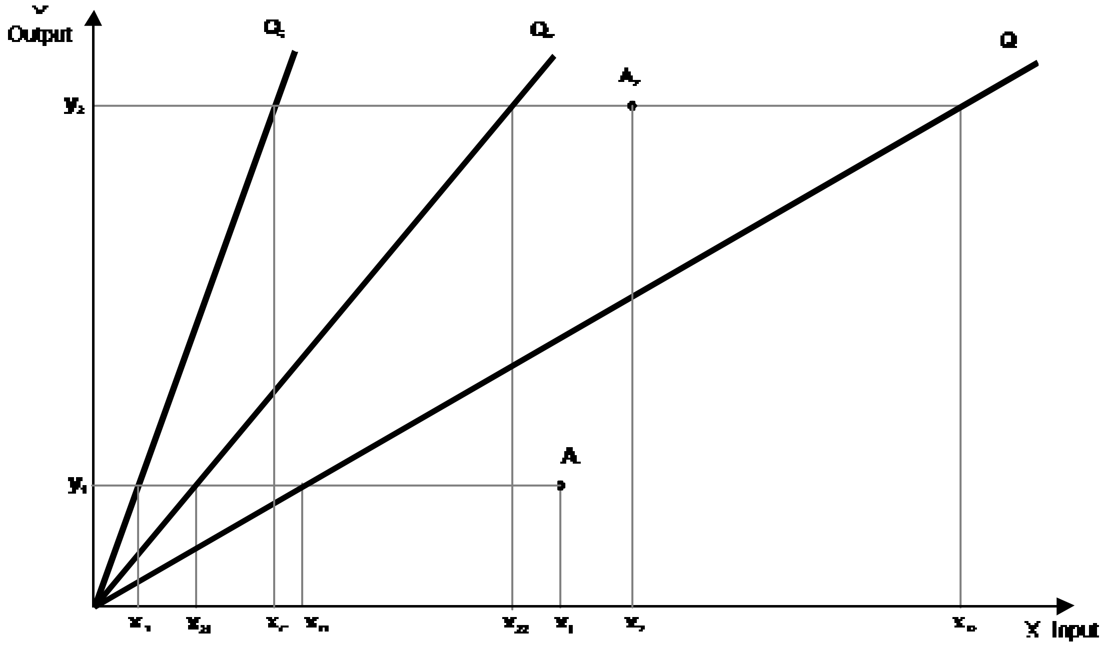
The convexity constraint $S_j l_j=1$ provides the basis for measuring economies of scale within the DEA concept (cf. Grosskopf 1986). It determines how closely the production frontier envelops the observed input-output combinations. Specified as an equality, the restriction allows for variable returns to scale (VRS) and creates the closest fit. Relaxing the convexity restriction corresponds to tightening the scale restrictions, thereby restricting the shape of the production frontier and loosening its fit around the data. All firms that operate at low output levels like A, B, and G in Figure 1 are able to lower their average costs by increasing size towards an output level like C. At this output level the firm will operate at minimal average costs. Increasing output further will bring the firm into the range of decreasing returns to scale or increasing average costs, respectively. In Figure 1 this applies for firms D and H. Obviously, scale inefficiencies can occur in the case of small as well as large firms and will reduce CRS efficiency scores compared to the VRS case. The scale restriction that proves to be binding for a firm determines whether the firm exhibits increasing, constant, or decreasing returns to scale. Technical details can be found in Färe, Grosskopf, and Lovell (1985).

Scale efficiency is defined as the ratio $q_0^S = q_0^{CRS} / q_0^{VRS}$, where q_0^{CRS} is the efficiency score under CRS and q_0^{VRS} the efficiency score under VRS. Because the linear program under VRS is more constrained than under CRS $q_0^{CRS} \leq q_0^{VRS}$ and the measure for scale efficiency is less than or equal to one, by definition. The scale efficiency thus measures the relative distance between the frontiers under VRS and CRS. A value smaller than one indicates that by adjusting to a more efficient size, the firm would be able to lower its average cost. The scale inefficiency ($1-q_0^S$) gets smaller the closer a firm approaches the optimal output level.

For the measurement of technical progress in financial services several authors suggest the Malmquist productivity index, which represents a combination of efficiency scores over time. This approach is particularly popular for the banking industry (cf. Berger – Humphrey, 1997). For the European insurance industry, however, we know only of applications to Italian (Cummins, Turchetti, and Weiss 1996), Spanish (Cummins and Rubio-Misas, 1998), and Austrian insurance companies (Mahlberg and Url, 1998).

The Malmquist productivity index (TFP) measures the development in total factor productivity for an individual firm. It is based on the efficiency scores of several DEA computations, where the input bundles of a single firm are compared to production frontiers from different periods of time.

Figure 2: *Computation of the Malmquist Index from efficiency frontiers of subsequent periods*



There are several versions of the Malmquist index. We use the one proposed by Försund (1993) which allows us to chain indices over time and thus fulfill the circular relation condition demanded by Frisch (1930). Under this condition, productivity development over time can be broken down consistently into subsequent year to year changes. This can be illustrated by firm A in Figure 2. The input-output combinations of firm A are shown in relation to envelopes from two consecutive periods (Q_1, Q_2) and a reference period Q_i. In order to understand the concept of the Malmquist index for the productivity development between the first and second periods with respect to the reference period *i*, $\text{TFP}_i(1,2)$, it is useful to decompose it into two components:

$$TFP_i(1,2) = TP_i(1,2)\, EP(1,2),$$

where $TP_i(1,2)$ represents the relative shift of the production frontier *Q* between the first and second period, i.e. the technical progress (*TP*). This component indicates the general development of productivity in the industry, or to be more precise, the productivity change of the benchmark firm. The second component, *EP*(1,2), represents the efficiency progress (*EP*) of a firm and measures the change in the relative position of A with respect to production frontiers Q_1 and Q_2. This can be interpreted as a catching up effect towards the best practice firms. Specifically,

$$TP_i(1,2) = \frac{x_{i2}/x_{22}}{x_{i1}/x_{11}}$$

represents the ratio of the efficiency score of A in period 2 relative to the production frontier Q_i to the efficiency score of A in period 1 relative to the production frontier Q_i. If the value for $TP>1$ the production frontier of the second period Q_2 lies to the left of Q_1 and we can confirm technical progress between the first and second period. In the case of $TP_i<1$ the production frontier Q_2 lies to the right of Q_1 and we recognize technical regress. The efficiency progress is defined as:

$$EP(1,2) = \frac{x_{22}/x_2}{x_{11}/x_1},$$

which corresponds again to a ratio of efficiency scores but in this case with respect to production frontiers from periods 1 and 2. If $EP>1$ holds, we conclude that A improved its relative position with respect to the benchmark firm over time. In Figure 2 this would correspond to a catching up process where A_2 is closer to Q_2 than A_1 is to Q_1. In the case $EP<1$ the firm lost touch with competitors and its relative position to the benchmark deteriorated. Translated into Figure 2 this would imply that A_2 lies further away from Q_2 than A_1 does from Q_1. Consequently, if $TFP>1$ holds, the total factor productivity of the firm in question increased between periods 1 and 2, whereas a $TFP<1$ indicates a decline in total factor productivity.

The chaining property of this approach guarantees that $TFP_i(1,3) = TFP_i(1,2)\cdot TFP_i(2,3)$ etc., whereas the usual updating of the reference technology results in losing this property, i.e. $TFP_1(1,3) \neq TFP_1(1,2)\ TFP_2(2,3)$. The chaining property not only holds for the Malmquist index but also for both its components.

Measures of Inputs and Outputs

There are numerous measures suggested for inputs as well as outputs of insurance companies. Actual measurement suffers from the fact that insurance companies provide financial services that mainly consist of monetary transactions and output is not easy to pin down. We will focus on the basic idea that insurance - through the law of large numbers – allows individuals to form risk pools, such that individual losses can be averaged out within each pool. To be specific, consider an exchange economy with C identical consumers and a single good. The endowment of that good available to each consumer, w, is stochastically determined. There are two states of nature: with probability $(1-p)$ the consumer will have the full amount w at his disposal and with probability p an accident will reduce his endowment by the loss L. So we can distinguish between two states of nature for the consumer: the "no-accident" state and the "accident" state. The probability of having an accident does not depend on the consumer. If the number of consumers is large enough, i.e. tends toward infinity, we can apply the law of large numbers to get the following per capita endowment for the ith consumer:

$$c_s^i = w(1-p) + (w-L)p = w - pL, \qquad \forall i = 1,\ldots,M, \qquad \forall s = 1,\ldots,S.$$

where S represents the number of possible states of nature ($S=2^M$), and c_s^i is the consumption level of individual i in state s. By using a von Neuman-Morgenstern utility function, $u(.)$, we can analyze the welfare consequences of stochastic accidents. If we assume the usual conditions of positive first and negative second derivatives of the utility function, then it can be shown that a competitive and ex ante Pareto optimal Arrow-Debreu equilibrium exists (Laffont, 1989).

Insurance companies provide a simple institutional structure to achieve a Pareto optimal allocation of goods by collecting a premium payment and reimbursing all agents who suffer an accident by the amount of their loss L. If there are no transaction costs and the zero profit condition for insurance companies holds, the actuarially fair premium requires that the individual premium is equal to the expected value of the loss. The endowment of an insured consumer is equal to the expected average endowment and for concave utility functions every consumer has an incentive to join the insurance pool and protect himself fully against losses. This is illustrated in Figure 3, where the optimal allocation A is characterized by the tangency between the utility function of the ith consumer and the budget line provided by the insurance company (0A). Without insurance the consumer would receive w in the good state and $w-L$ in the bad state, but by paying the premium the average expected endowment can be established in advance.

By introducing transaction costs, T, from organizing the insurance pool one can achieve a more realistic picture. The maximization problem of the household is slightly changed. For a given price of the insurance policy, p, a representative household chooses its level of consumption in both states and the amount of coverage, $z=(1-\mathbf{g})L$, where $\mathbf{g}$ is the share of uncovered losses, by solving the problem:

$$\max_{z}[(1-\mathbf{p})u(w-pz)+\mathbf{p}u(w-pz-L+z)].$$

The first-order condition for utility maximization is then

$$(1-\mathbf{p})u'(w-pz)q=\mathbf{p}u'(w-pz+z-L)(1-p),$$

where $u'(.)$ indicates the first derivative of the utility function with respect to the degree of coverage γ. It can be shown that for zero transaction costs $p=\mathbf{p}$ and that the slope of the indifference curve at the diagonal is equal to the slope of the budget line running from 0 to A. In Figure 3 this corresponds to a slope of $-(1-\mathbf{p})/\mathbf{p}$. At this actuarially fair premium we will find full coverage ($\mathbf{g}=0$). If, due to positive transaction costs, the price for insurance exceeds the fair price, $p>\mathbf{p}$, the slope of the budget line will get flatter and the optimal solution for the consumer will be at C, where another indifference curve reflecting a lower level of utility is tangent to the new budget line. The slope of the budget line can be derived by substituting a simple mark up rule $p=\mathbf{p}(1+T)$ into the first order condition and corresponds to the right hand side of the following equation:

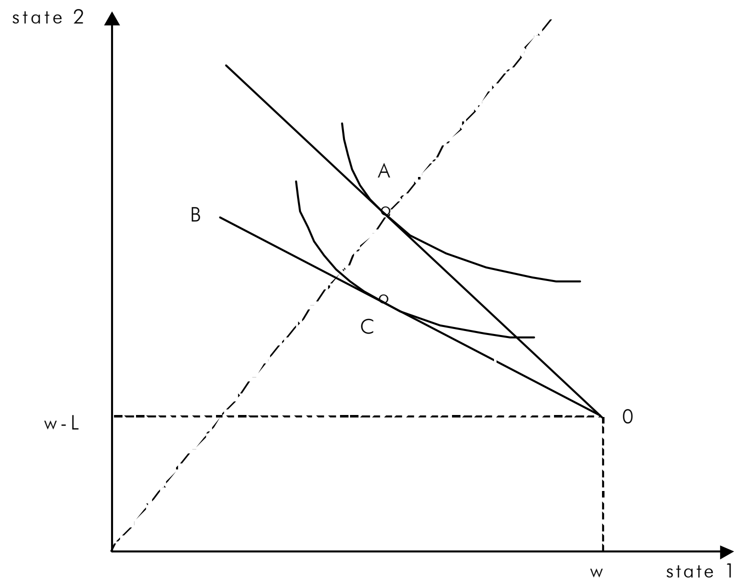
$$\frac{(1-\mathbf{p})u'(w-\mathbf{p}(1+T)z)}{\mathbf{p}u'(w-\mathbf{p}(1+T)z-L+z)}=\frac{1-\mathbf{p}(1+T)}{\mathbf{p}(1+T)}$$

The wedge between the fair and the gross premium reduces the chosen degree of coverage and therefore lowers the utility which the household may achieve. Introducing insurance taxes or incomplete competition in the insurance industry makes it more difficult for households to achieve complete insurance.

The activity of insurance companies can therefore be summarized as creating and administrating a risk pool. Transaction costs result in incomplete coverage of private households. The output, on the other hand, is the provision of smoothed income streams for households, conditional on the occurrence of a loss, since this is what actually generates utility for households.

This measure of efficiency naturally reflects a consumer's view of insurance activity rather than a shareholder's perspective. The lower the transaction costs are, the higher will be the relation between outputs and inputs and thus measured efficiency. Our measure should be positively related to standard profit oriented indices because low cost insurance companies are likelier to generate higher profits. A major advantage of our efficiency measure, especially with respect to the German market, is its independence from tax oriented manipulations of the balance sheet.

Figure 3*: The choice of insurance under transaction costs*



Data

For the empirical application we use inputs and outputs closely related to the concept developed in the previous section, i. e. we use only flow variables to model insurance activities. Since insurance companies are financial intermediaries most of their financial flows are simple monetary transfers between agents in the insurance pool. Only part of the premium is used to cover the costs of organizing the insurance pool. These costs will be interpreted as transaction costs, which create a wedge between the fair and the actual insurance premium. We regard administration costs together with distribution costs as transaction costs, i.e. the monetary equivalent to inputs for each insurance company.

The choice of outputs corresponds closely to the concept of risk pooling and smoothed income streams outlined in the previous section. Claims payments, for example, are directly dedicated to the compensation of income losses. But claims payments alone do not suffice to measure smoothed income completely because for some insurance contracts long periods exist between premium and claims payment during which provisions are built up. Life insurance is a classic example, where premium payments continue over periods as long as 30 years or even longer while claims payments follow afterwards. For this reason adding changes in technical provisions to the output of insurance companies is necessary, since this is the book accounting equivalent of future claims payments. Thus firms with low claims payments will nevertheless show a high level of efficiency as long as they build up provisions.

The third item we consider a component of insurance output is returned premiums, which predominantly represents allocated investment returns in life and health insurance. Bonuses and rebates in the property liability insurance form a negligible part. Nevertheless, they must be included in our output measure, because such payments contribute to the income-smoothing characteristic of insurance underwriting. Excluding bonuses and rebates would create the wrong image of a low output when good states of nature accumulate.

In Germany insurance companies are forced by law to set up separate firms for the life, health, and property liability business. Composite insurers can only be built by creating a group or a holding company with subsidiaries for each line of business. Most of the German insurance companies are part of a group and their activities and strategies are coordinated by an overlapping board of directors. Moreover, general services like trademark advertising, distribution channels, data processing, or financial and technical administration are often provided for the whole group. Profits can be easily shifted throughout the company by applying internal pricing schemes. To take this possibility into account we merge all members of a group into one firm, which produces services in three lines of business (health, life, and property liability insurance). So we are able to distinguish three outputs according to their likely differences with respect to distribution channels, actuarial characteristics, and administrative organization. For each of these three lines of business we add claims, net-changes in provisions, allocated investment returns, bonuses, and returned premium into a single output indicator.

Since most of the German insurance companies offer insurance in at least two lines of business it is not reasonable to attribute expenditures for inputs directly to one risk class. Consequently, we compare the three outputs of each firm with one input indicator, i. e. the aggregation over risk classes occurs only within the input dimension. Thus we are able to capture the multiple product characteristic of insurance services, while allowing for heterogeneity within the output dimension. The input for the combined group encompasses items like expenditures on labor, material, energy, depreciation, marketing, commissions and the like.

To achieve full comparability of input and output variables we subtract the reinsurance part from all variables. All inputs and outputs are measured in Deutsche Marks (DM). The data comes from current issues by Rehnert and annual business reports. During the sample period between 444 and 508 firms were supervised by the Federal Supervisory Agency. Additionally, agencies of the states (Länder) supervised between 20 and 25 insurers. We aggregate these companies into 161 groups. A familiar problem for panel data is the exit and entry of firms over time. In order to achieve a complete panel we eliminate those insurance companies with missing values in the sample period. This and removal of outliers reduces the sample to 114 groups, which still cover around 92 percent of total written gross premiums. Firms removed from the panel typically represent companies that used the freedom to provide services under a single license and prudential control or companies newly entering the German market. Thus, by eliminating outliers or firms with missing observations from the sample, we do not introduce a survivor bias. Table 3 gives a statistical summary of the variables for the year 1996.

Table 3: *Summary statistics of inputs and outputs for German insurance companies, 1996*

Variable	Description	Mean Value	Standard deviation	Minimum	Maximum
			Mill. DM		
Input	Administration and distribution costs[1])	321.9	626.8	0.5	5,106.4
Output 1	Health insurance[2])	335.0	1,018.1	0.0	6,181.5
Output 2	Life insurance[2])	1,119.0	2,586.7	0.0	21,961.6
Output 3	Property-liability insurance[2])	471.3	1,014.7	0.0	8,752.1

S: *Rehnert* (1997) and annual reports. Sample size is 444 firms collapsed into 114 groups. - [1]) All lines of business. - [2]) Claims payments + net change in provisions + allocated investment returns, bonuses, and returned premia.

Results

Table 4 presents efficiency scores under assumptions of both VRS and CRS on the production technology for insurance companies. The statistics for the variable returns to scale (VRS) case indicate higher efficiency scores compared to the results under the constant returns to scale (CRS) assumption. This is to be expected from the construction of the optimization problem under VRS, since in this case the efficiency boundary is curved and more points of support are required for the tighter envelope (cf. Figure 1). Under VRS the average efficiency score is about 49 percent, indicating that the average firm has a potential for cost cutting of around 50 percent. On average, 15 companies or 13 percent of the sample are fully efficient and form a benchmark. Under CRS the average efficiency score is 39 percent and the potential for efficiency gains fluctuates between 56 and 64 percent. Under both assumptions some firms can be found with efficiency scores below 20 percent. These firms could theoretically save about 80 percentage points of their cost. These insurers are very small and new in the market. Building up their organization and distribution channels imposes high start up costs and consequently lowers efficiency scores.

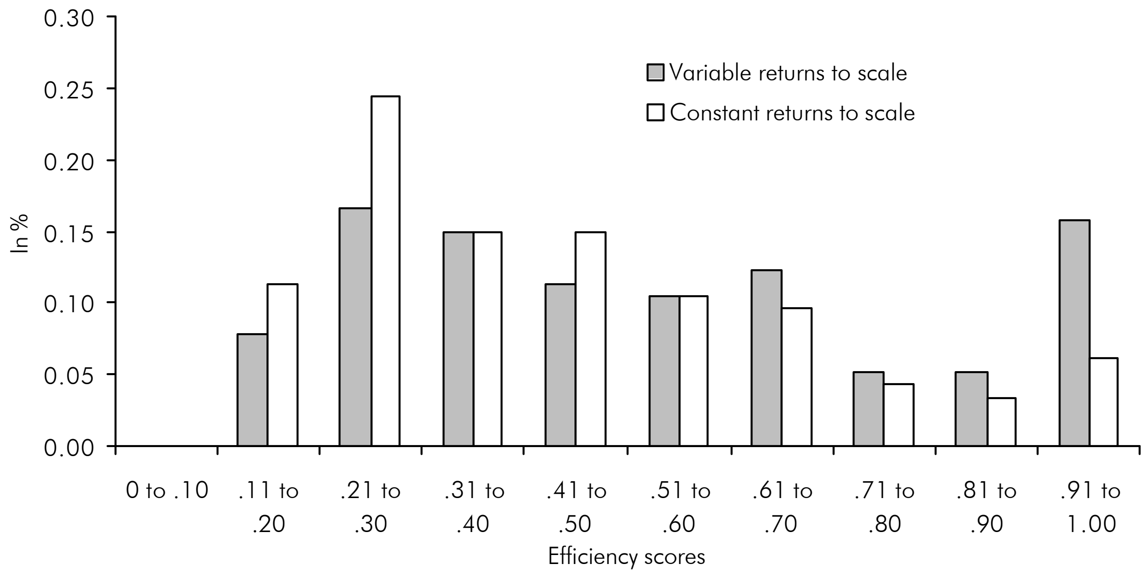
The distribution of efficiency scores is given in Figure 4 where 10 percent classes are distinguished in a histogram. Actually, around half of the firms have scores below 50 percent under VRS and less than one third of the insurers have efficiency scores better then 70 percent. Under CRS technology the share of firms with scores of 70 percent and above falls dramatically to 14 percent, whereas two thirds of the firms show efficiency scores below 50 percent.

Table 4*: Efficiency Scores under Variable Returns to Scale (VRS) and Constant Returns to Scale (CRS)*

	1992	1993	1994	1995	1996	Average
VRS						
Geom. mean	0.553	0.539	0.464	0.469	0.459	0.495
Standard deviation	0.266	0.267	0.284	0.261	0.273	0.253
Maximum	1	1	1	1	1	1
Minimum	0.139	0.099	0.117	0.109	0.101	0.112
Number of efficient companies	19	15	15	12	13	15
Efficient companies (in percent)	17	13	13	11	11	13
CRS						
Geom. mean	0.443	0.384	0.362	0.39	0.383	0.394
Standard deviation	0.235	0.206	0.259	0.223	0.234	0.211
Maximum	1	1	1	1	1	1
Minimum	0.059	0.087	0.081	0.108	0.101	0.085
Number of efficient companies	4	5	4	4	4	4
Efficient companies (in percent)	4	4	4	4	4	4
Scale efficiency						
Geom. mean	0.802	0.713	0.782	0.832	0.834	0.781
Standard deviation	0.173	0.175	0.188	0.165	0.167	0.152
Maximum	1	1	1	1	1	1
Minimum	0.159	0.236	0.119	0.202	0.245	0.186
Number of efficient companies	7	6	7	8	11	8
Efficient companies (in percent)	6	5	6	7	10	7
Number of firms in the range of						
Decreasing returns to scale	83	93	68	49	71	73
Constant returns to scale	7	6	7	8	11	8
Increasing returns to scale	24	15	39	57	32	33

Note: Sample size is 114.

Figure 4: *Histogram of efficiency scores in 1996*



Note: Sample size 114.

Given the industry wide phenomenon of mergers and acquisitions it is interesting to examine whether firms can actually improve their efficiency by increasing their size. Table 4 also presents average scale efficiencies for all years, i. e. the relative distance between the CRS and the VRS envelope. The average value of 78 percentage points indicates that insurance companies would be able to improve their efficiency on average by 22 percentage points by adjusting to the right size. The minimum value of 15 percent indicates that there are firms in the German insurance market which deviate heavily from their optimal size. Counting the number of firms within each range of scale economies we find comparatively more firms in the decreasing returns area, between 1992 and 1996 on average 73 (c.f. Table 4). But a detailed inspection of this surprising result leads to the conclusion that small units deviate more heavily from the optimum value as compared to larger units. This implies a steep VRS envelope in the region of small firms which, for larger companies, approaches the same slope as the CRS envelope. Transferred into average cost curves we find an almost L-shaped average cost curve, which falls steeply for small units but takes only a small positive slope after reaching the lower turning point. Thus benefits from enlargement are big for small units but get smaller as the firm size grows.

In a second step we try to explain the variation of efficiency scores among individual companies by linking the scores with firm specific exogenous variables. These exogenous variables should be out of the control of the insurance company management and are motivated by our discussion of the development of the European insurance industry during the first years of the Single Market. They are also motivated by our interest in the effects of several indicators related to the size of insurance companies, their degree of diversification, profitability and their ownership structure. As our output measure relies on claims payments it is subject to stochastic variations in the number and value of accidents. Within our rather short sample period risk clustering, which indicates years of large losses or extraordinary business activity, may occur despite the adjustment of our output measure. To correct such effects we use the claims ratio, i. e. the ratio between claims and premium payments, to condition our results on possible loss clustering.

Economies of scale are approximated by the size of a company, which is measured as the log of the premium income of the group. Second, we introduce a variable for measuring economies of scope. The diversification of premiums in each of the three lines of business is measured by a Herfindahl Index. This index approximates economies of scope and increases with the concentration of premiums within a single product line (Tirol, 1989).

Not all branches of the insurance business will be exposed to the same level of foreign penetration. Insurance contracts with short durations are more prone to competition than pension plans or private health insurance. For this reason we construct a risk structure index, which reflects the exposure of individual insurance companies with respect to the property liability business, which is characterized by short contract periods.

Another variable that has an impact on the efficiency of insurance companies is the age of the firm. Since there are high entry costs during the build up phase of the risk pool, older companies face lower average costs. Within conglomerates we choose the age of the oldest company as the representative value for the whole group.

Finally, the ownership structure may be important in the German market. About one tenth of total premiums are collected by foreign firms. To capture this effect we introduce a dummy variable which is one for foreign and zero for domestic firms. A further interesting issue that has been discussed extensively in the literature is the effect of the organizational form on performance (cf. Cummins, Weiss, and Zi, 1999). Two major hypotheses are suggested, namely the "expense preference hypothesis" (Mester, 1989) and the "managerial discretion hypothesis" (Mayers and Smith, 1988). Both hypotheses derive from agency theory. The expense preference hypothesis of organizational form predicts that mutuals will have higher costs than stocks because the stock market imposes a more effective mechanism for corporate control and reduces excessive consumption of perquisites by managers and eventual deviation from profit maximization principles.

Farmer and Jensen (1983a, 1983b) hypothesize that stocks and mutuals will be sorted into market segments where they have comparative advantages in dealing with various types of principal-agent problems. The managerial discretion hypothesis predicts that stock insurers should be more successful in lines of insurance requiring relatively high levels of managerial discretion because stock ownership provides a superior mechanism for controlling principal-agent conflicts between managers and owners (Mayers and Smith, 1988). Agency theory also predicts that mutuals should be relatively more successful in lines of insurance where policyholder-owner conflicts are important, because both functions are merged in mutuals.

Cummins, Weiss, and Zi (1999) show that, in contrast to the expense preference theory, mutuals perform better than stock companies; Fecher et al. (1993) got the same result, and Swiss Re (1999) reaffirms that mutuals cannot be regarded as an endangered species any more. On the German insurance market stock companies compete with mutuals as well as with publicly owned insurers. Thus, in Germany organizational issues are extended to public versus private ownership. Therefore, we define three dummy variables for each organizational form: stock, mutuals, or public companies. As we mentioned above we aggregate the different firms into conglomerates in order to integrate connections among firms. The aggregation into groups assumes that the behavior of the subsidiary company of a mutual or a public firm is very similar to the behavior of the parent although they may be quoted as stock companies (cf. Finsinger, 1983). Thus conglomerates where the dominant firm is a mutual or a public company are classified accordingly.

The efficiency scores of the insurance companies are related to exogenous variables in a Panel regression over the sample period 1992 through 1996. We apply a general to specific model search. Starting from the most general model we subsequently eliminate insignificant variables by Likelihood Ratio tests. Allowing for fixed or stochastic firm effects, we cannot find an exogenous variable for the explanation of efficiency scores that significantly adds to the information provided by firm specific effects. When using only the information of individual years, for example 1992 or 1996, we are able to identify several significant variables. The preferred model, however, changes from year to year, such that we cannot establish a stable relationship.

The Single Market effects on the insurance industry are somewhat hidden in a pure analysis of efficiency scores. Since they are a relative measure at a point in time their development over time provides no information about productivity changes in the whole industry. The Malmquist

Index allows us to connect the information from efficiency scores over time and thus provides a better picture of transition periods. For the computation of the Malmquist Index we choose 1992 as the base year and transfer all series into 1992 price levels by applying the GDP-deflator uniformly to all inputs and outputs[1]) The results over the period 1992 through 1996 are presented in Table 5. Our sample period comprises the years in which the second and third generations of insurance directives were incorporated into German law and is therefore of particular interest with respect to its impacts on productivity changes. In the period after 1994 the Single Market was completed and thus full market access was possible for insurance companies throughout the European Union.

Table 5: *The Malmquist Index for the German insurance industry decomposed into efficiency progress and technical progress, 1992 to 1996*

	1992 to 1993	1993 to 1994	1994 to 1995	1995 to 1996	1992 to 1996
Efficiency Progress (EP)					
Geom. mean	0.867	0.943	1.076	0.983	0.864
Standard deviation	0.379	0.447	0.394	0.305	0.592
Maximum	4.068	2.332	3.977	2.316	6.237
Minimum	0.133	0.261	0.631	0.438	0.301
Technical Progress (TP)					
Geom. mean	1.145	1.083	1.001	1.052	1.305
Standard deviation	0.186	0.344	0.244	0.057	0.198
Maximum	1.476	1.594	1.385	1.139	1.69
Minimum	0.937	0.678	0.731	0.972	1.081
Malmquist Index (TFP)					
Geom. mean	0.992	1.021	1.077	1.034	1.128
Standard deviation	0.358	0.284	0.284	0.315	0.845
Maximum	4.102	1.979	2.915	2.555	8.814
Minimum	0.125	0.251	0.493	0.488	0.326

Note: Sample size is 114.

The first row of each block in Table 5 presents the geometric mean of individual firm indices in our sample during the period 1992 through 1996. The first block depicts the development of efficiency progress, the second block changes in technical progress and the third block compounds this information into the Malmquist Index. The Malmquist Index indicates with the exception of the change from 1992 to 1993 a mixed picture of mild and strong productivity growth; total factor productivity increased by 12 percent. The combination of efficiency and technical progress, however, hides a strong growth of benchmark firms, especially in the two years before the implementation of the Single Market. At the same time, laggards lost further ground relative to benchmark firms in every period except the year from 1994 to 1995.

The last column of Table 5 shows the productivity change over the whole sample period. Between 1992 and 1996 the average firm suffered an efficiency loss of 14 percent while benchmark firms could improve their productivity by 30.5 percent. This divergence suggests a very unequal development of individual companies on the German market. While few very efficient firms were successful in the reduction of their cost ratios about two thirds of the

[1]) This simplification erases all relative price movements between inputs and outputs over time. Given the low inflation rates over the sample period the consequences are likely to be small.

remaining companies suffered from a further deterioration of their position compared with benchmark firms and struggled with their adjustment to the new institutional background and enlarged market opportunities.

A second step regression analysis of the Malmquist Index and its sub-indices sheds some light on the sources of productivity gains in the German insurance industry. We expect the effects of the German unification to be mixed up with Single Market effects, although in the course of time impacts of the Single Market will be felt more and more strongly. For this reason we choose the same set of explanatory variables as already motivated in the analysis of efficiency scores. Additionally, we introduce the efficiency score of the year 1992 into the regression because we expect firms with comparatively bad performance to make a bigger effort to improve their relative position to the benchmark.

Table 6 reveals that the initial position was actually an important determinant of efficiency gains during the period 1992 to 1996. The negative sign on the initial score value in the regression of the efficiency progress indices shows that laggards in 1992 undertook greater efforts during the next few years and developed a catching up behavior. Interestingly, the technological progress index reveals the reversed sign, i. e. firms with a superior technological growth record during 1992 through 1996 tended to be the ones who were already in good shape in 1992. The overall Malmquist Index is dominated by the effect of the initial position on the efficiency progress.

Table 6*: Estimation results for determinants of productivity changes in the German insurance industry, 1992 to 1996*

Explanatory variables	Explained variable: Efficiency progress	Technical progress	Malmquist index
	coefficient value		
Constant	1.155 **	1.576 **	1.839 **
Stock company	-	-	-0.113 *
Age	-0.001 *	-	-0.001 **
Share of prop.-liability	-0.144 *	-0.494 **	-0.625 **
Initial score (1992)	-0.282 **	0.039 **	-0.382 **
R^2	0.10	0.96	0.36
SEE	0.25	0.04	0.32
P-value normality test[1])	0.55	0.20	0.84
P-value White test[2])	0.31	0.00 **	0.22

Note: OLS regression, sample size is 111 due to outliers in all equations,
* indicates significance at the 10% level, ** indicates significance at the 5% level.
[1]) Jarque-Bera-Test on normality. - [2]) White-heteroscedasticity-test.

Furthermore, a high share of premiums in the property liability business reduces both efficiency and technological progress during our sample period. A similar effect comes through the age of an insurance company. The older a firm was the smaller were its productivity gains. With respect to the overall Malmquist Index we can replicate a well known result from other studies: stock companies show on average smaller productivity gains as compared to publicly owned or mutual insurers. With the exception of the regression for the technological progress index all residuals are well behaved. A heteroscedasticity corrected estimate for this equation hardly changes t-values and thus the significance levels of coefficients remain unchanged.

Summary and Conclusions

The German insurance industry experienced two major shocks during the '90s. First, the expansion of the market size as a consequence of the German unification and second, the introduction of the Single Market throughout the European Economic Area. The unification provided a unique opportunity to expand quickly into an under-insured market, where government transfers secured a comparatively high-income standard. Many German companies used this opportunity to establish traditional distribution networks or implement innovative distribution channels. The movement into the East German market obviously created once off shifts in costs but allowed at the same time an increase in business activity. On top of that, the Single Market creates pressure on firms to innovate and introduce new technologies in order to improve their relative cost position.

The panel of German insurance companies in our sample covers the period 1992 through 1996. The results of a Data Envelopment Analysis (DEA) indicate higher efficiency scores for the variable returns to scale (VRS) case as compared to the assumption of constant returns to scale (CRS). Under VRS the average efficiency score is about 50 percentage points, indicating that the average firm has a potential for cost cutting of around 50 percentage points. Under CRS the potential for efficiency gains is even larger and fluctuates around 60 percentage points. This outcome is to be expected from the construction of the optimization problem and indicates economies of scale of considerable size.

Over the years between 1992 and 1996 the variation in average scores is rather small and the standard deviation across companies falls only slightly. The increased pressure from competition - whether due to domestic preemptive price reductions or due to foreign penetration - did not result in converging efficiency scores, i.e. the differences among firms remained practically constant.

According to the difference between the CRS and VRS envelopes, the average insurance company would be able to save 20 percentage points of its costs by adjusting to the right size. We find asymmetries between firms in the increasing and decreasing returns to scale area. Large firms tend to be closer to or at the efficiency frontier, whereas small firms deviate on average strongly from the best practice. Therefore, the increasing returns to scale branch of the VRS-frontier is farther apart from the CRS-frontier than its corresponding decreasing returns branch. This result indicates asymmetries in the average cost curve of German insurance companies. The average cost curve falls steeply for small units and gets a slightly positive slope for large firms. This almost resembles the common L-shaped average cost curve for the insurance industry and provides a strong rationale for mergers and acquisitions of small units.

Attempts to relate efficiency scores with additional information on companies, for example their size, fail due to the dominance of idiosyncratic developments of individual firms. In a Panel regression firm specific effects explain all significant variations among German companies. This suggests that managerial skills clearly outweigh size effects, at least as far as efficiency scores are concerned.

The productivity growth during 1992 and 1996 was impressive. Measured by the Malmquist index the average firm was able to increase its performance by 13 percent. The improvements, however, are unequally distributed across companies. While a few already efficient firms were able to enhance their productivity levels further, individual gaps towards the benchmark increased as well. Thus the strong overall performance hides a picture of exceptional technological progress of benchmark firms (30 percent plus), while the gap towards the benchmark grows at the same time. The so-called efficiency progress measures catching up behavior and indicates that the average efficiency loss against the best practice companies between 1992 and 1996 was 14 percent.

A more detailed analysis of the Malmquist Index shows that the initial efficiency position of firms does make a difference. Laggards in 1992 tended to show higher efficiency progress during the first years of the Single Market. Large differences between minimum and maximum values of the Malmquist Index indicate that many companies are specialized in niche markets with a small group of targeted customers and a high degree of market segmentation. On the other hand, specialized distribution lines and regional strongholds allow for superior cost structures, however, these may hinder the introduction of new organizational structures and innovative products. In this respect the age of a company imposes a negative effect on the productivity performance of insurers.

A more interesting explanatory variable for productivity growth is the share of premium intakes in the property and liability business. The higher this share the smaller the consecutive productivity growth of German insurers. This result is somewhat puzzling, because the price competition had its biggest impact on the automobile insurance business and thus one would expect those firms to be most eager for productivity improvements. Obviously, the transition to the Single Market is not yet completed and firms are sluggish in their response to falling profit margins.

References

Berger, A. N., Humphrey, D. B. (1997): "Efficiency of Financial Institutions: International Survey and Review", European Journal of Operational Research, 98, pp. 175-212.

Charnes A., Cooper W. W., Rhodes E. (1978): "Measuring the Efficiency of Decision Making Units", European Journal of Operational Research, 2, pp. 429-44.

Cummins, J. D., Rubio-Misas, M., (1998): "Efficiency in the Spanish Insurance Industry", mimeo Wharton Financial Institutions Center, University of Pennsylvania, Philadelphia, PA.

Cummins, J. D., Turchetti, G., Weiss, M. A. (1996): "Productivity and Technical Efficiency in the Italian Insurance Industry", Working Paper No. 96-10, Wharton Financial Institutions Center, University of Pennsylvania, Philadelphia, PA.

Cummins, J. D., Weiss, M. A. (1998): "Analyzing Firm Performance in the Insurance Industry Using Frontier Efficiency Methods", Working Paper No. 98-22, Wharton Financial Institutions Center, University of Pennsylvania, Philadelphia, PA.

Cummins, J. D., Weiss, M. A., Zi, H. (1999): "Organizational form and efficiency: The Coexistence of Stock and Mutual property-liability insurers ", Management Science, 45, pp. 1254-1269.

Färe, R., Grosskopf, S., Lovell, C. A. K. (1985): "The Measurement of Efficiency of Production", Kluwer Nijhoff, Boston.

Farmer, E., Jensen J. C. (1983a): "Separation of Ownership and Control", Journal of Law and Economics 26, pp. 301-325.

Farmer, E., Jensen J. C. (1983b): "Agency Problems and Residual Claims", Journal of Law and Economics 26, pp. 327-349.

Farrell, M. J. (1957): "The Measurement of Productive Efficiency", Journal of the Royal Statistical Society, Series A, Vol. 120, pp. 253-81.

Fecher, F., Kessler, D., Perelman, S., Pestieau, P. (1993): "Productive performance of the French insurance industry", The Journal of Productivity Analysis, 4, pp. 77-93.

Federal Supervisory Agency (1997): "Annual Report 1996, Part B", Berlin.

Finsinger, J. (1983): „Versicherungsmärkte", Campus, Frankfurt am Main.

Försund, F. R. (1993): „Productivity Growth in Norwegian Ferries", in Fried, H. O., Lovell, C. A. K., Schmidt S. S., „The Measurement of Productive Efficiency, Techniques and Applications", Oxford University Press, Oxford, pp. 352-373.

Frisch, R. (1930): „Necessary and Sufficient Conditions Regarding the Form of an Index Number Which Shall Meet Certain Fisher's Tests", Journal of the American Statistcal Association, 25, 1930, pp. 297-406.

Grosskopf, S. (1986): "The Rule of the Reference Technology in Measuring Productive Efficiency", Economic Journal, Vol. 96, pp. 499-513.

Kessler, D., (1991): "Comments on the Studies on the Performance of the Insurance Industry", Geneva Papers on Risk and Insurance, 59, pp. 143-153.

Klein, W. (1991): "Der Versicherungsmarkt in den neuen Bundesländern", Versicherungswirtschaft, No. 15/1991, pp. 202-206.

Laffont J.-J. (1989): "The Economics of Uncertainty and Information", MIT-Press, Cambridge MA.

Mahlberg, B., Url, T. (1998): "Effects of the Single Market on the Austrian Insurance Industry", Austrian Institute of Economic Research Working Paper No. 97, Vienna.

Mayers, D., Smith, C. W. (1988): "Ownership Structure Across Lines of Property-Casualty Insurance", Journal of Law and Economics, 31, pp. 351-358.

Mester, L. (1989): "Testing for Expense Preference Behavior: Mutual Versus Stock Savings and Loans", Rand Journal of Economics, 20, pp. 483-498.

Rehnert, K-H. (1995): "Versicherungreport 1994 - Jahrbuch der Versicherungwirtschaft", VVW, Karlsruhe.

Rehnert, K-H. (1997): "Versicherungreport 1996 - Jahrbuch der Versicherungwirtschaft", VVW, Karlsruhe.

Rehnert, K-H. (1998): "Versicherungreport 1997 - Jahrbuch der Versicherungwirtschaft", VVW, Karlsruhe.

Sheldon, G., Haegler, U. (1993): "Economies of Scale and Scope and Inefficiencies in Swiss Banking", in Blattner, N., Genberg, H., Swoboda, A. "Banking in Switzerland", Physica Verlag, Heidelberg.

Swiss Re (1996): "Deregulation and liberalization of market access: the European insurance industry on the threshold of a new era in competition", Sigma No. 7/1996, Zurich.

Swiss Re (1999): "Are mutuals an endangered species?", Sigma No. 5/1999, Zurich.

Tirol, J. (1989): "The Theory of Industrial Organization", MIT Press, Cambridge MA.

Wagner, P.-R. (1991): "Versicherungen in den fünf neuen Bundesländern – Chancen und Risiken", Zeitschrift für Betriebswirtschaft, 61, No. 7/1991, pp. 721-736.