Cranfield
UNIVERSITY
School of Management

RP 4/07

THE IMPACT OF DEREGULATION ON THE GERMAN AND UK LIFE INSURANCE MARKETS: AN ANALYSIS OF EFFICIENCY AND PRODUCTIVITY BETWEEN 1991 - 2002

Research Paper Series

The Cranfield forum for the latest thinking in management research

Available online at www.som.cranfield.ac.uk/som/research/researchpapers

Research Paper no. 4/07

THE IMPACT OF DEREGULATION ON THE GERMAN AND UK LIFE INSURANCE MARKETS: AN ANALYSIS OF EFFICIENCY AND PRODUCTIVITY BETWEEN 1991 - 2002

Stephanie Hussels[a] and Damian R. Ward[b*]

[a] *School of Management, Cranfield University, Cranfield, Bedford MK43 0AL, United Kingdom*
[b] *School of Management, University of Bradford, Emm Lane, Bradford BD9 4JL, UK*

March 2007

The Cranfield School of Management Research Paper Series was established in 1987. It is devoted to the dissemination of new insights which advance the theory and practice of business and the management of organisations.

The Research Papers in this Series often represent preliminary work. They are circulated to encourage cross-fertilisation of ideas both between Cranfield scholars and across the wider academic community.

ISBN: 1 85905 184 7

Editor: Catarina Figueira

For further information, please contact: *Cranfield School of Management Research Paper Series*
Cranfield University, Cranfield , Bedford MK43 0AL, UK
Tel. +44 1234 751122 extension 3846
Fax. +44 1234 752136
E-mail. Catarina.Figueira@cranfield.ac.uk

[*] Corresponding author. Tel. +44 (0)1274 233194; Fax: +44 (0)1274 546866.
E-mail address: D.R.Ward@bradford.ac.uk .

Research Paper no. 4/07

THE IMPACT OF DEREGULATION ON THE GERMAN AND UK LIFE INSURANCE MARKETS: AN ANALYSIS OF EFFICIENCY AND PRODUCTIVITY BETWEEN 1991 – 2002 *†

Abstract

This paper provides an intra and inter-country assessment of deregulation and industry efficiency in the European insurance industry. The impact of deregulation is expected to be magnified within an analysis of the Continental maximal regulated German industry and the Anglo minimal regulated UK industry. Results suggest that while increased competition in the UK is reflected in higher intra-industry cost efficiency; an inter-industry analysis indicates that the German industry dominates UK cost efficiency both before and after deregulation. These results maybe explained by the efficiency enhancing nature of German regulation.

Key words: deregulation, life insurance, Germany, UK, frontier methodologies

* *Stephanie Hussels gratefully acknowledges the research support from the Economics and Social Research Council (ESRC) and the University of Bradford School of Management studentship fund.*

† *An earlier version of this paper has been published in the Bradford School of Management Working Paper Series.*

1. Introduction

In 1994 the Third Generation Insurance Directive deregulated the European insurance market. By enabling insurance companies to operate across national boundaries and by removing regulations on pricing and product ranges, the process of deregulation was expected to spawn improvements in cost efficiency and productivity growth.

The process of deregulation was expected to make a greater impact on markets and firms which previously operated in highly regulated environments. For example, in contrast to the pre-existing deregulated UK market; Germany with a high degree of price, product and operational regulation, was a clear candidate for significant change (Grenham *et al.*, 2000). The German life insurance market moved from a maximal-regulation policy, which emphasised insurer solvency, control of insurance rates and policy conditions; to a lighter European regulatory approach (Rees and Kessner, 1998). The German regulated model created a stable and transparent market for consumers, but one coupled with low levels of price competition and limited product ranges.

Regulation was, therefore, viewed as a competitive restraint and a disincentive to improve efficiency. However, this could have been a naïve view. Regulation may dull competition, but it may not necessarily reduce incentives to be efficient. In the utilities incentive regulation occurs in the form of cost-based pricing formulas, under which firms can stretch margins by continually improving efficiency, see Hattori *et al.* (2005) and Uri (2002). Therefore, in the absence of competition, appropriate regulation can drive improvements in efficiency.

The purpose of this paper is to address the impact of insurance market deregulation through a comparison of the UK and German markets pre and post deregulation. By comparing the productivity developments of the highly competitive UK market with deregulated German market, it is possible to evaluate the beneficial impact of the Third Generation Insurance Directive.

This study adds to the literature by focusing on the life insurance sector; and in so doing does not confound the analysis within a combined study of life and non-life, as conducted by Mahlberg and Url (2000) and Cummins and Rubio-Misas (2006)[1]. In a further contrast to the previous studies, this paper examines efficiency pre and post deregulation and significantly extends the ex-post period to better capture any gains from deregulation.

The paper is organized as follows. In section two, the operational and regulatory characteristics of the German and UK life insurance markets are discussed. Section

[1] A detailed overview of the remaining efficiency studies covering the European insurance industry are given in the two survey papers by Cummins and Weiss (1999) and Berger and Humphrey (1997).

three links industry deregulation to pricing, competitiveness, consolidation, and ultimately efficiency. The choice of variables is discussed in section four. Section five presents the results; and section six offers conclusions and proposes avenues for future research.

2. The German and UK life insurance sectors

The importance of the European life insurance market is immense. Representing 37% of total world life premiums, the European market leads the US's world share by 11 percentage points. While the US is still the single biggest country level market, the UK ranks second and Germany fifth, measured by premium volumes (Swiss Re, 2005). Between 1999 and 2003, the European life insurance industry showed the biggest world-wide insurance industry growth rate and has often outpaced GDP growth (Swiss Re, 2001). An understanding of deregulation and productivity developments in the industry is of great interest to academics and policymakers.

In terms of country differences, UK companies, measured by premiums written are, on average, seven times bigger than their German counterparts. The importance of insurance companies' financial assets also vary, with German companies representing 39.1% of GDP and UK companies achieving a ratio of 110.1% (GDV, 2003). German product distribution is predominately through tied agents, while the UK has maintained a significant use of independent agents. This makes entry into the German market more difficult. Forcing companies to either use expensive independent distribution, or enter by acquisition to gain access to distribution.

In terms of regulation, two distinct regulatory approaches evolved in Europe, the Anglo and the Continental approach. The Anglo approach in the UK and the Netherlands has enabled entrepreneurial freedom, leaving product development, price setting, and serving overseas markets to the discretion of insurance companies. In contrast, the Continental approach popular in Germany, Italy and Austria, emphasized maintaining insurer solvency, control of insurance rates, and policy conditions. Supporting this characterization Hogan (1995) in a survey of insurance managers' perception of regulatory intensity found higher levels of perceived regulations in Germany; and lower levels in the UK and the Netherlands.

The aim of the supervisory office in Germany was to achieve complete, clearly arranged, and standardized insurance contract terms. New contracts by one provider were discussed by members of the industry and consumer groups before being approved. Insurance firms used very similar policies, which effectively ruled out product competition. In the UK, no contract regulations existed. Germany also encountered limited price competition, through the imposition of cost plus pricing formulas on the industry. Regulated prices were typically set at 30% of average industry costs; enabling the most inefficient providers to remain in the market. Even efficient firms faced a penalty for good performance, with rules ensuring that 90% of

surpluses were distributed to policyholders through terminal bonuses; see Rees and Kessner (1998) for further details.

UK life insurance companies faced none of these restrictions and similarly were relatively unrestricted in their investment decisions. While the investment portfolios of UK companies were heavily weighted towards equities, German regulations forced companies to hold the majority of their assets in low yielding government and secured debt (Swiss Re, 1996).

UK regulation was most apparent in the provision of sales and investment advice to potential consumers, (Ward, 1997). However, following a policy of increased product disclosure, the regulator sought to reduce informational asymmetries between the insurer and the potential insured; and as such, regulations were designed to make the market work more effectively. In contrast, German regulations focused on the maximum commissions paid to agents and the amount of revenue that could be allocated to advertising spend, which in both cases reduced effective competition.

It is clear that the Anglo based system of the UK and the Continental based system of Germany engendered differing competitive effects. Since the Third Insurance Directive transmitted a regulatory model similar to that of the UK across Europe, then it is envisaged that deregulation had the greatest impact on the level of competitiveness and productive development in the German life insurance sector.

3. Deregulation, competition, and efficiency

Deregulation was expected to have a number of beneficial consequences. First was the improvement in operating efficiency. By lowering the level of regulation, administrative resources could be reduced, or transferred to output generating activities. The facilitation of cross-border competition was also envisaged to improve competition and ultimately operating efficiencies. While the removal of pricing and product regulation was anticipated to enhance competitive intensity amongst existing domestic insurance companies.

In terms of previous empirical evidence, Mahlberg and Url (2000) and Cummins and Rubio-Misas (2006) indicate that increased domestic competition has been the most evident characteristic of deregulation. Similarly, OECD (2003) provides strong evidence that the number of foreign firms operating in the German and UK markets remained almost constant. Suggesting that allowing and enabling cross border trade are different, see Amel *et al.* (2004).

Increased domestic competition can occur through a number of routes. The removal of price regulation can lead to competition based on cost leadership. Less efficient firms must then, either: (i) raise their level of efficiency, (ii) move to a differentiated niche, or (iii) exit the sector completely. In all regards, increased price competition

places pressure on firms' margins, which should lead to a ratcheting up of the industry's efficiency.

Industry level efficiency can improve if either: i) inefficient firms catch-up with their efficient rivals; or ii) the most efficient firms, through technological improvement, continue to lead efficiency gains. In the Spanish industry, Cummins and Rubio-Misas (2006) found that technological improvements were limited, but the acquisition of inefficient firms by efficient rivals resulted in a catch-up effect. While in Germany Mahlberg and Url (2000) found little consolidation and little by way of a catch-up effect. However, greater development in technological improvements did drive efficiency forward.

It is important to note that the argument that deregulation drives competition, which then drives improvements in efficiency maybe a naïve view. In fact the view that firms within a highly regulated environment are lax in their pursuit of commercial objectives, is not necessarily true. Rate of return regulations cap profits and are generally seen to minimize firms' eagerness to reduce costs. However, regulating price can provide firms with incentives. Generally seen in the utility industries, incentive regulations are applied by allowing price increases which are lower than the rate of inflation. If profits are to rise, firms must be more cost efficient. Regulations fixed German prices at 30% of average industry costs. Being the most cost efficient producer was a clear way to boost a firm's profits.

There is growing empirical support for incentive regulation, with Hattori *et al.* (2005) showing that cost efficiency improved faster in the UK electricity sector under price controls, than in Japan with no price regulations. Similarly, Uri (2002) finds some evidence in support of incentive regulation and efficiency in the US telecommunications market. This study will be able to add to this literature by examining whether regulation in Germany stifled competition and efficiency. Or actually managed to promote the development of efficiency amongst the leading firms.

The purpose of this study is to provide an improved assessment of the efficiency improvements brought about by deregulation[2]. The approach is to take the UK as a benchmark of a deregulated industry and then compare the development of productivity with the highly regulated German industry. This is similar to the approach used by Boonysasai *et al.* (2002), which compared the deregulated markets of Korea and the Philippines, with the regulated markets of Taiwan and Thailand.

A particular concern in the extant literature stems from the limited number of years under analysis, which centre closely on the initiation of deregulation, see Diacon et al

[2] It is recognised that Diacon *et al.* (2002) provide a cross-country comparison of efficiency in the combined life and non-life insurance sectors. But the study is only an ex-post analysis, focusing upon the years, 1996 to 1999; and potentially compounds the analysis by bringing scope economies into the analysis through the combined use of life and non-life companies.

(2002). An improved research design would enable a more longitudinal assessment of efficiency, where a greater gestation period for efficiency gains to occur is allowed. This approach will also enable an assessment of German cost efficiency under the regulatory framework.

An additional concern is that previous studies of insurance market deregulation have used the non-parametric data envelopment analysis, DEA, to measure efficiency. However, Weill (2004) has shown for the European banking industry that there is a significant lack of comparability between parametric and non-parametric techniques for measuring efficiency. This raises a concern that the results of Mahlberg and Url (2000) and Cummins and Rubio-Misas (2006) are highly conditioned on the choice of estimation method used. Therefore, this study checks the rank correlation of the DEA approach with the parametric distribution free approach; and in so doing adds to the literature on the comparability of alternative efficiency measurement techniques.

4. Methodology and data

4.1. Methodology

Cost efficiency is measured by the estimation of efficient frontiers. The efficient frontier represents the optimal cost level for a given use of inputs in the creation of output. Based upon the sample, the frontier is comprised of benchmark firms with an efficiency score of 100%. The distance of the remaining firms from the frontier provides a measure of their inefficiency. Following Dietsch and Lozano-Vivas' (2000) comparison of the French and Spanish banking sectors, this study estimates single country and combined frontiers. Single country frontiers assume a comparability of productive technology within a country and enable a comparison of intra country efficiency. Common frontiers assume a similarity in technology across countries and thereby enable a comparison of inter country efficiency.

It is assumed that the reader is familiar with the various parametric and non-parametric approaches for estimating inefficiency, which are discussed in detail in Bauer *et al.* (1998) and Cummins and Weiss (1999). Given that both Bauer *et al.* (1998), Cummins and Zi (1998), and Weill (2004) find a high rank correlation amongst alternative parametric approaches, the choice of a particular parametric comparator to DEA is unlikely to impact the comparability assessment. This study, therefore, utilizes the parametric distribution free approach, DFA, introduced by Berger (1993), preferring its lack of an assumed distribution for the efficiency term. The average residual for each firm proxies for its measure of efficiency, when it is assumed that the random element of the residual averages to zero. Noting that random errors may not perfectly cancel each other out, the residuals are truncated at the upper and lower 5% of the distribution. As in Hardwick (1997) and Ward (2002) a translog cost function is employed; and then in order to deal with zero outputs, a Box-Cox transformation, as outlined in Khaled *et al.* (2001), is utilized.

The non-parametric approach utilizes data envelopment analysis, DEA, and follows the cost specification proposed by Färe *et al.* (1994) and operationalized within the software package DEAP (Coelli, 1996). In order to understand the determinants of the overall cost efficiencies in the German and UK industries, the DEA efficiency measures are separated into technical, scale and allocative efficiency. A variable returns to scale (VRS) specification is adopted to avoid efficiency estimates being confounded by scale efficiencies. Finally, to facilitate an understanding of the dynamic development of efficiency, Malmquist indices were also estimated using DEAP. Based on the assumption that during periods of regulatory changes and increases in competition firms are likely to focus on cutting costs, the DEA and Malmquist index estimation used in this study are input-oriented. Input-orientation addresses how much the input quantities can be proportionally reduced without changing the output quantities produced.

4.2. Data

The data covers the years 1991 to 2002. The German data was collected manually from the respective annual company accounts. After eliminating inactive firms and firms where data were only available for part of the sample period, thirty-one life insurance companies, accounting for 65 percent of total premiums, were included in the final sample. The UK data were drawn from companies' annual accounts for the period 1991-1995; and for the remaining period from EuroThesys, which compiles UK insurance company accounts in one database. After eliminating inactive firms and firms with incomplete data, the sample comprised 47 firms, representing 76 percent of the industry premiums. Since all observations are for firms who have survived the entire period, then these maybe the most efficient firms. This could lead to an upward bias in the annual measure of efficiency, known as survivorship bias and needs to be recognized when interpreting the results.

In line with the majority of existing studies, such as Cummins *et al.* (1996), Hardwick (1997), Cummins and Zi (1998), Ward (2002), and Cummins and Rubio-Misas (2006), this paper adopts the value added approach to identify and measure insurance outputs. Life insurance companies provide two main services to customers, risk-bearing/risk-pooling services and financial intermediation. A common means of measuring risk-bearing and risk-pooling has been the use of net premiums written. However, Doherty (1981) argues, that net premiums are price times output and are likely to result in simultaneous equation bias. The price element of premiums is a particular concern in this study, where the high degree of German regulation may have resulted in higher prices, which would be mistakenly measured as higher output and higher efficiency. Incurred benefits to policyholders is an alternative proposed by Berger *et al.* (1997) However, Diacon et al (2002) question whether management will seek to maximize the value of insurance claims. Furthermore, when compared with premiums, claims can suffer from unwanted stochastic variability, adding unwanted noise to the model. This study's preferred measure is net written premiums and follows Hardwick (1997), Ward (2002), and Diacon *et al.* (2002). This also reflects a

pragmatic consideration where the German definition of claims changed at the inception of deregulation making it difficult to construct a consistent measure of claims throughout the sample period. However, in recognizing that the German measure of premiums maybe inflated by the average cost-plus pricing regulation, we check the robustness of our results by also using claims from 1995-2002.

The measurement of intermediation services is also contested within the literature. Cummins and Rubio-Misas (2006) use the real value of invested assets, but as a stock measure, it is difficult to see how this variable is capable of capturing the flow characteristics of value added. This study follows Yuengert (1993) and utilizes additions to reserves, which represent additional accrued benefits to policyholders. This accords with the approach of Mahlberg and Url (2000) and closely matches investment returns proposed by Diacon *et al.* (2002).

Two input measures are included for estimating the frontier functions, namely labor and cost of capital, which is in line with the existing literature (Cummins and Weiss, 1999). To capture the effects of labor and capital over the twelve years of the study, the annual average number of employees per company and total assets minus total liabilities, at the end of each financial year, are used. As in Hardwick (1997) and Ward (2002), the price of labor is measured by the average gross weekly earnings of workers in the insurance sector. Measurement of the cost of capital is more complicated by the incidence of mutual organizations within the industry. The cost of capital for each year is estimated by utilizing the traditional capital asset pricing model[3]. All variables were deflated to 1995 prices using GDP deflators for each country. All variables were then converted into US$ for comparative purposes, using the exchange rate published by the International Monetary Fund (2003).

The descriptive statistics for each country are provided in Table 1. While German companies collect greater premium income than UK companies, the opposite is true of additions to reserves. These two results may reflect the differing regulatory environment, with German companies investing in less risky, lower yielding assets; whilst also being able to charge higher regulated, non-market determined prices for insurance.

[3] The cost of capital was estimated by using the CAPM formula ($k=r_f+ß(r_m-r_f)$). The risk free rate (r_f) for each year was approximated by using short term government bonds as published by the International Monetary Fund (2003) and the market premium (r_m) were measured by a benchmark market index. Beta, the measure of the systematic and non-diversifiable risk, was approximated for each year by taking the industry betas published in Kielholz (2000) and own estimations.

Table 1: Descriptive statistics

	Germany				UK			
Variable	Mean	Stdev	Max	Min	Mean	Stdev	Max	Min
Addition to reserves (Mio US $)	478.2	831.4	7,820.2	0	706.1	1,698.4	20,653.1	0
Total claims (Mio US $)	754.5	987.9	5793.2	0	405.7	765.1	4539.5	0
Total premiums (Mio US $)	1,025.1	1,265.8	7,484.2	0	803.2	1,329.7	14,179.2	0
Shareholders Equity (Mio US $)	1,586.3	2,661.5	18,188.0	33.04	6,232.4	8,532.5	54,293.4	0
Cost of capital (%)	4.84	1.85	8.28	2.72	6.39	2.01	11.19	3.78
Number of employees	1,703	2,312	12,423	5	2,884	4,785	33,583	23
Weekly wage rate US $	753.34	60.07	873.02	653.90	660.69	46.61	735.05	570.90
Number companies	31				47			

5. Results

Table 2 provides an assessment of the comparability of the DEA and DFA efficiency measures[4]. For both countries the mean DEA efficiency score exceeds the DFA score. This is similar to Weill's (2004) finding for the European banking sector. But one which contrasts with the results of Bauer *et al.* (1998) for the US banking industry, where an intuitive argument is made for higher mean parametric efficiency scores on the basis that the inclusion of an error term controls for statistical noise and measurement error. However, Weill (2004) argues that a comparison of the rank order of efficiency scores across the two approaches is more important for policy decisions, than a consistent ranking of average efficiency scores. In this regard, the Spearman rank correlation coefficients for both the UK and Germany are positive and statistically significant. This result strongly contrasts with the European banking sector, where Weill (2004) reports statistically insignificant rank correlations. Nevertheless, for this study, we have strong evidence in support of comparability

[4] The estimated coefficients for the translog cost functions are available from the authors.

across the parametric and non-parametric approaches to efficiency measurement; and we can feel reasonably confident in the singular use of DEA.

Table 2: Comparability of DEA and DFA cost efficiency

	UK		Germany	
	DEA	DFA	DEA	DFA
Mean	0.744	0.531	0.574	0.444
Stdev	0.2993	0.1629	0.3116	0.1930
Spearman Rank Correlation	0.3354***		0.4308**	

Notes:
*** = Correlation is significant at the 0.01 level
** = Correlation is significant at the 0.02 level.

Table 3 presents the various DEA measures of efficiency using net premiums as the output measure. The estimates are calculated from separate frontiers for Germany and the UK, enabling an examination of efficiency within each country. In addition, using the pooled sample of German and UK, efficiency is calculated from a joint, global frontier, enabling a comparison of efficiency across countries. To check, in particular, that the German efficiency scores are not inflated by German regulation on cost-plus pricing, we checked our results using claims during the post regulation period, see Figure A1 and Table A1 in the appendix. There is a very strong rank correlation between efficiency scores for each firm estimated using premiums and claims. German average overall cost efficiency follows a similar path when using claims or premiums. Although as expected, claims is more stochastic. In the case of the UK, overall cost efficiency from claims and premiums follow similar trends, although premiums generates a higher level of efficiency. While recognizing the UK difference between claims and premiums, the rank correlations, similar trends and similar efficiency scores, at least in the case of German, indicate that the use of premiums will generate representative results.

Taking the UK first as the benchmark country, overall cost efficiency declined over the period 1991 to 2002, but did show some improvement post 1995. With an average cost efficiency of 65%, the average firm could be expected to reduce its costs by 35%.

Table 3: VRS based cost, technical, allocative and scale efficiencies

UK	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	mean
Cost	0.75	0.575	0.756	0.638	0.588	0.637	0.698	0.709	0.649	0.608	0.580	0.639	0.652
Technical	0.832	0.762	0.839	0.732	0.775	0.771	0.798	0.844	0.748	0.733	0.727	0.751	0.776
Allocative	0.955	0.821	0.931	0.874	0.824	0.838	0.867	0.838	0.827	0.789	0.848	0.879	0.858
Scale	0.710	0.196	0.601	0.548	0.654	0.216	0.759	0.585	0.609	0.506	0.732	0.566	0.557

Germany	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	mean
Cost	0.564	0.576	0.537	0.535	0.566	0.499	0.573	0.571	0.584	0.595	0.568	0.552	0.560
Technical	0.821	0.810	0.739	0.719	0.724	0.738	0.745	0.764	0.782	0.784	0.791	0.753	0.764
Allocative	0.664	0.680	0.682	0.693	0.729	0.697	0.709	0.692	0.696	0.708	0.666	0.678	0.691
Scale	0.711	0.788	0.830	0.804	0.729	0.717	0.738	0.564	0.618	0.619	0.637	0.797	0.713

Germany and UK		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	mean
Cost	G	0.549	0.548	0.531	0.534	0.566	0.586	0.570	0.566	0.581	0.594	0.562	0.552	0.562
	UK	0.567	0.441	0.686	0.328	0.185	0.338	0.430	0.446	0.519	0.410	0.386	0.287	0.419
Technical	G	0.809	0.739	0.718	0.721	0.734	0.742	0.764	0.782	0.784	0.791	0.753	0.763	0.758
	UK	0.572	0.455	0.695	0.332	0.191	0.346	0.439	0.454	0.526	0.417	0.392	0.290	0.426
Allocative	G	0.648	0.646	0.676	0.693	0.732	0.760	0.711	0.686	0.694	0.707	0.660	0.678	0.691
	UK	0.984	0.953	0.984	0.983	0.973	0.969	0.975	0.974	0.981	0.975	0.975	0.982	0.976
Scale	G	0.711	0.788	0.831	0.806	0.734	0.722	0.743	0.564	0.618	0.619	0.637	0.797	0.714
	UK	0.580	0.253	0.553	0.523	0.846	0.448	0.907	0.561	0.488	0.351	0.463	0.455	0.536

These results are in line with those of Hardwick (1997), Ward (2002), and the joint consideration of life and non-life business by Diacon *et al.* (2002). Importantly, the UK results are much higher than the 17% cost efficiency in the Spanish industry provided by Cummins and Rubio-Misas (2006) and the 36% provided by Mahlberg and Url (2000) for the German industry. Therefore, despite the decline in UK cost efficiency, many firms in the industry appear to be achieving high levels of cost efficiency. This arguably reflects the less stringent regulatory regime and the more competitive environment.

The UK excels in allocative efficiency, with a high mean of 86%, indicating that UK firms are good at using the correct mix of labor and capital for a given level of output. Although, it could also reflect increased outsourcing of activities, which would lower the reported number of employees. In contrast, scale efficiency has been both declining and volatile in the UK. This may reflect merger activity. This could be a point of concern for policymakers, since competition and consolidation can also lead to falling scale efficiency, which is then compounded by market dominance and power over pricing.

Turning to Germany, overall cost efficiency varied very little over the period 1991 to 2002 and averaged 56%, suggesting that the average firm could reduce their costs by 44%. The lack of variation; and, moreover, the lack of improvement in cost efficiency is somewhat surprising given the scale of deregulation in Germany. While clearly there was a drop in cost efficiency in 1996, arguably reflecting the industry's adjustment costs to the new regulatory environment, there is no subsequent short, or long-term trend growth in cost efficiency above the pre-deregulation levels. The lack of change in efficiency may support the view that price controls were as equally good as competition at promoting efficiency.

The results for technical, allocative and scale efficiencies stay close to their mean values throughout the period; and often the higher values for these series occur before deregulation in 1995. Only in the case of technical efficiency is there evidence of a positive trend post 1995. Therefore, the evidence in support of deregulation driving improvements in efficiency is limited; and stands in stark contrast to the findings for Spain by Cummins and Rubio-Misas (2006). However, with only 14% cost efficiency in 1991, the Spanish faced ample more opportunity to improve efficiency than the Germans.

Before considering pooled results it is important to note that DEA can be sensitive to outliers; and given the different size distributions of the UK and German companies it is sensible to check the robustness of the pooled results. This was achieved by re-estimating the DEA scores with the top and bottom 5% efficient firms removed from the sample. Then the rank correlations between the efficiency scores for the truncated and full sample were calculated. These are reported in Table A2 in the appendix and show a high degree of correlation, indicating that the results are not impacted by outliers.

From the joint frontier, German cost efficiency is estimated at 56% and the UK's at 42%. The German industry is more likely to be defining the global frontier; and is therefore the more efficient industry[5]. This is a persistent finding throughout the period and contrasts with the view that Germany was over-regulated and potentially uncompetitive. The lack of improvement in the German single frontier efficiency scores is consistent with the pooled results that Germany was and is a reasonably efficient insurance sector when compared with the deregulated UK. This tends to support the view that the German industry was able to promote efficiency even in the absence of competition, perhaps through price regulation.

Where the German industry succeeds is in delivering technical and scale efficiency. The UK still dominates the German industry in terms of allocative efficiency, perhaps reflecting the greater ease with which UK employment law enables companies to reassign, or dismiss surplus labor. However, as a cautionary note, if UK companies make greater use of outsourcing than German firms, then the average number of workers will be lower in UK firms. This would be erroneously picked up as improved allocative efficiency.[6]

Table 4 presents the Malmquist indices of total factor productivity changes. For the UK, a 4% decline in technical efficiency is partially offset by a 2.2% improvement in technological efficiency. Therefore, while the best practice frontier improved each year by 2.2%, a number of firms managed to fall away from the frontier resulting in an overall reduction in total factor productivity. Germany also managed a 2.2% technological improvement and with a 0.5% improvement in technical efficiency managed to raise total factor productivity. The size of the technological improvements are in line with those found by Cummins and Rubio-Misas (2006) for Spain and lie within the range of productivity gains found in the European banking industry by Casu *et al.* (2004). Furthermore, as in the banking sector, improvements in productivity seem to hinge more on technological improvements, than on catch-up effects. This suggests that industry level productivity gains are driven more by leading firms pushing out the frontier each year, as opposed to underperforming firms striving to reduce their technical inefficiency. This again suggests that deregulation does little to improve efficiency in the presence of firms who have previously faced alternative regulatory incentives to be efficient.

[5] Efficiency scores using claims reduced UK efficiency; and not German efficiency. Therefore, the dominance of German efficiency is the same whether net premiums or claims are used as the output measure.

[6] We thank an anonymous referee for making this point.

Table 4: Malmquist indices

UK	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02	91/02
Effch												
Mean	0.389	2.317	0.817	1.222	0.354	2.981	0.864	1.019	0.706	1.294	0.837	0.960
Stdev	0.587	1.838	0.486	2.488	0.408	2.116	0.473	0.85	0.766	0.584	0.598	0.751
Max	3.594	7.595	2.688	17.735	2.267	10.383	2.694	3.28	4.013	2.851	3.588	17.735
Min	0.102	0.084	0.166	0.315	0.149	1	0.261	0.083	0.144	0.306	0.271	0.083
Techch												
Mean	2.924	0.38	0.965	0.984	2.863	0.425	1.163	0.904	1.144	0.792	1.035	1.022
Stdev	1.473	0.256	0.135	0.249	0.967	0.192	0.375	0.316	0.122	0.154	0.363	0.421
Max	6.848	1.718	1.313	1.958	4.623	1.215	2.477	1.667	1.461	1.492	2.354	6.848
Min	0.885	0.176	0.596	0.737	0.737	0.324	0.691	0.479	0.931	0.627	0.336	0.176
Tfpch												
Mean	1.113	0.880	0.789	1.202	1.014	1.267	1.005	0.922	0.827	1.025	0.866	0.981
Stdev	0.997	0.434	0.409	2.812	0.550	0.956	0.962	0.596	0.854	0.571	0.543	0.677
Max	5.613	2.221	2.407	19.597	4.110	4.694	5.481	2.850	5.588	3.355	3.334	19.597
Min	0.162	0.018	0.159	0.252	0.389	0.337	0.298	0.061	0.113	0.293	0.100	0.018

Germany	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02	91/02
Effch												
Mean	1.192	1.029	0.962	0.877	0.984	0.926	0.916	1.129	1.034	1.002	1.040	1.005
Stdev	2.516	0.755	0.178	0.166	0.250	0.208	0.372	0.330	0.218	0.149	0.310	0.830
Max	15.085	5.058	1.310	1.200	1.913	1.705	2.775	2.783	1.394	1.349	2.198	15.085
Min	0.872	0.759	0.596	0.617	0.444	0.554	0.430	0.743	0.552	0.773	0.495	0.430
Techch												
Mean	0.989	1.035	1.106	1.255	1.015	1.019	1.091	0.918	0.978	0.928	0.948	1.022
Stdev	0.153	0.142	0.181	0.149	0.068	0.066	0.130	0.121	0.298	0.172	0.058	0.177
Max	1.507	1.223	1.515	1.595	1.250	1.139	1.320	1.177	1.947	1.232	1.106	1.947
Min	0.625	0.705	0.945	1.062	0.883	0.810	0.949	0.684	0.787	0.374	0.811	0.374
Tfpch												
Mean	1.178	1.065	1.065	1.100	0.998	0.944	1.000	1.036	1.011	0.929	0.985	1.026
Stdev	2.465	0.645	0.245	0.210	0.261	0.215	0.444	0.232	0.354	0.197	0.322	0.813
Max	14.798	4.519	1.774	1.914	1.936	1.683	3.340	2.009	2.558	1.232	2.172	14.798
Min	0.843	0.574	0.722	0.787	0.431	0.580	0.535	0.508	0.589	0.347	0.468	0.374

Notes:

effch = Efficiency change relative to constant returns to scale frontier
techch = Technological change
tfpch = Total factor productivity change

An explanation for the UK's under performance in improving technical efficiency maybe found in the use of additions to reserves as an output measure. With UK companies being more heavily dependent upon equities for investment returns than their German counterparts, then the output of UK firms is more volatile (relative to its inputs). This may explain why the total factor productivity scores for Germany are more stable than those for the UK.

In order to understand the factors that lead to improved levels of efficiency, the various measures of efficiency, cost, technical, allocative and scale, were regressed on a variety of organizational variables and time dummies. These broad categories of organizational and time variables enable a clearer distinction to be drawn between firm level determinants of efficiency and time varying regulatory influences.

A Tobit specification was used to accommodate the efficiency score lying between 0 and 1. The second stage analysis of efficiency scores within Tobit models is customary within the efficiency literature and out-performs alternative approaches, see Hoff (2006). However, a note of caution needs to be heeded when interpreting the results. Brocket *et al.* (2005) argue that CCR type DEA, as used in this paper, may generate non-metric efficiency data, which invalidate any additional parametric testing of the data. Furthermore, variables used in the second stage which are correlated with variables used to estimate the efficiency scores can lead to biased coefficients.

The independent variables and their hypothesized relationship with efficiency are detailed in Table 5. A novel feature of this research is the recognition of differing asset classes in the investment portfolio of insurance companies. The results from the regression analysis are presented in Table 6[7].

For the UK, only the 1996 time dummy is significant. Providing evidence of an immediate, but not a sustained impact on efficiency following deregulation. In the case of Germany, there is evidence of an immediate and sustained reduction in cost efficiency following deregulation. This result is echoed in the estimates for allocative efficiency. Therefore, the decline in German cost efficiency post 1995 maybe more closely linked to employment constraints within German employment law and a recessionary economy, than any pressures brought about by deregulation.

The only consistent firm level factor, across the two samples, is found for administrative expenses, which are seen to negatively impact cost and technical efficiency. Suggesting that underwriting, enquiring handling and business management are a key aspect of efficient performance.

[7] Investment costs, debenture and loan holdings are not reported by UK companies and so were excluded from the UK model.

Table 5: Descriptive statistics for Tobit model of efficiency

Variable	Description	Hypothesized relationship with efficiency	Germany				UK			
			Mean	Stdev	Max	Min	Mean	Stdev	Max	Min
Organizational form	Dummy variable: 0=Mutual, 1=Stock company	+/-	0.67339	0.46992	1	0	0.72973	0.44485	1	0
Acquisition costs	Acquisition costs as a % of total premiums	-	0.15850	0.08021	0.61585	0	0.16611	0.30128	3.00823	0
Administrative costs	Administrative costs as a % of total premiums	-	0.04704	0.02619	0.18476	0	0.11056	0.16627	1.04656	-0.92529
Expenses incurred in the administration of investments	Expenses incurred in the administration of investments as a % of total investments	-	0.00481	0.01449	0.12923	0				
Investment portfolio	Land and equivalent titles and buildings including buildings and leased land as a % of total assets	+/-	0.03232	0.02263	0.09650	0	0.03124	0.04130	0.21884	0
	Shares in affiliated companies plus investments in affiliated companies and participating interests as a percentage of total assets as a % of total assets	+/-	0.04673	0.04532	0.20739	0	0.00832	0.02433	0.17401	0
	Shares, investment units and other non-fixed interest securities as a % of total assets	+/-	0.19928	0.11047	0.49298	0.00155	0.27992	0.79181	13.24139	0
	Bearer bonds and other fixed-interest securities plus loans secured by mortgages, land and annuity charges as a % of total assets	+/-	0.17886	0.08505	0.50352	0	0.21864	0.15991	0.79972	0
	Registered debentures plus borrowers' notes and loans as a % of total assets	+/-	0.42096	0.15741	0.87318	0				
	Loans and advance payments on policies as a % of total assets	+/-	0.00921	0.00507	0.03135	0				
	Deposits at banks plus current credit balances at banks, cheques, and cash on hand as a % of total assets	+/-	0.01472	0.01546	0.13579	0.00026	0.04763	0.06706	0.58016	0.00000
Solvency ratio	Total capital as a % of total assets	+	0.86071	0.10848	0.97996	0.40020	0.87662	0.11553	1.04783	0.52253
Debt ratio	Year-end total debt as a % of year-end total assets	-	0.11458	0.72253	11.35434	0.00154	0.03105	0.10243	1.30906	0.00001
Claims ratio	Incurred losses as a % of total premiums	-	0.64117	0.28127	1.64620	0.01624	3.66910	16.73944	156.86522	0.01726
Location	Germany: 0=West, 1=East ('Neue Bundesländer'); companies are differentiated according to postcode where headquarters are located	+/-	0	0.25	1	0	1	0.31	1	0
Age	Years since the point of the initial entry into the trade register	+/-	83	47	175	4	45	39	152	4
Size	Natural logarithm of total assets	+/-	8.54306	1.35322	11.45996	4.49838	15.14141	1.83956	18.51942	8.80193

Table 5: Descriptive statistics for Tobit model of efficiency (continued)

Variable	Description	Hypothesized relationship with efficiency	Germany				UK			
			Mean	Stdev	Max	Min	Mean	Stdev	Max	Min
Year 1996	Dummy variable: 1=1996, 0=other years	+	0.13	0.33	1	0	0.13	0.33	1	0
Year 1997	Dummy variable: 1=1997, 0=other years	+	0.13	0.33	1	0	0.13	0.33	1	0
Year 1998	Dummy variable: 1=1998, 0=other years	+	0.13	0.33	1	0	0.13	0.33	1	0
Year 1999	Dummy variable: 1=1999, 0=other years	+	0.13	0.33	1	0	0.13	0.33	1	0
Year 2000	Dummy variable: 1=2000, 0=other years	+	0.13	0.33	1	0	0.13	0.33	1	0
Year 2001	Dummy variable: 1=2001, 0=other years	+	0.13	0.33	1	0	0.13	0.33	1	0
Year 2002	Dummy variable: 1=2002, 0=other years	+	0.13	0.33	1	0	0.13	0.33	1	0
Time	Dummy variable: 1-8 for each year	+	4.50	2.30	8	1	4.50	2.30	8	1

Only in the case of German cost efficiency is there evidence supporting the hypothesis that the stock mode of organizational form is associated with improved levels of all efficiency measures. The lack of any support for the mode of corporate governance in the UK is in accord with Hardwick (1997) and Ward (2002).

There is no support in the UK results for efficiency improvements stemming from asset allocation. In the case of Germany, the increased use of loans, deposits, land, and debentures is associated with lower cost and technical efficiency, which may reflect the lower yield associated with these types of assets. There is evidence that higher claims are associated with improved cost, technical and allocative efficiency in the UK. This is likely to reflect how higher bonus payments on maturity lead to higher levels of current business.

Finally, younger and perhaps more innovative UK life insurers tend to be more efficient than their older rivals.

Table 6: Tobit regressions of company level efficiency

Variable	Germany				UK			
	CEFF	TEFF	AEFF	SEFF	CEFF	TEFF	AEFF	SEFF
Constant	2.110	1.062	2.048	1.181	0.514	0.435	0.839	1.343
	(0.635)***	(0.429)**	(0.473)***	(0.253)***	-0.470	-0.450	(0.316)***	(0.262)***
OrgForm	0.189	0.073	0.096	0.018	0.004	0.056	-0.022	-0.003
	(0.082)**	-0.054	-0.074	-0.035	-0.068	-0.061	-0.051	-0.039
Acq Costs	-0.534	-0.763	-0.183	-0.273	-0.011	-0.050	0.057	-0.061
	-0.522	(0.41575)*	-0.466	-0.272	-0.077	-0.075	-0.118	-0.085
Admin Costs	-5.907	-3.833	-1.894	-0.800	-0.828	-0.875	-0.226	0.185
	(2.001)***	(1.283)***	-1.355	-0.852	(0.179)***	(0.179)***	-0.147	-0.154
Inv Costs	0.106	-1.294	-3.161	0.897				
	-3.558	-2.628	-2.590	-1.448				
Land Inv	-0.059	-2.509	0.490	1.487	1.370	0.799	1.081	-0.949
	-1.782	(1.084)**	-1.538	(0.804)*	-0.939	-0.914	-0.674	-0.620
Aff Inv	-0.539	1.291	-0.655	-0.554	-2.293	-2.290	-1.617	-1.342
	-0.908	(0.522)**	-0.800	(0.300)*	-1.670	-1.722	-1.256	-0.833
Equity Inv	0.056	-0.320	0.128	0.424	-0.021	-0.012	-0.037	-0.049
	-0.380	-0.274	-0.296	(0.186)**	-0.149	-0.146	-0.147	-0.094
Bond Inv	-0.021	0.029	-0.535	0.131	0.241	0.277	0.053	0.406
	-0.462	-0.399	-0.378	-0.188	-0.157	-0.154	-0.147	(0.131)***
Deben Inv	-0.216	-0.386	-0.182	0.199				
	-0.249	(0.22417)*	-0.195	-0.123				
Loans Inv	-30.437	-20.171	-21.608	1.421				
	(6.981)***	(4.886)***	(6.487)***	-3.305				
Deposits Inv	-7.091	-4.473	-6.110	-0.080	0.789	0.962	-0.016	0.615
	(2.058)***	(1.351)***	(1.721)***	-0.918	(0.278)***	-0.330	-0.325	-0.440
Solvency Ratio	-0.981	0.302	-0.685	0.059	0.176	0.296	-0.011	-0.261
	(0.550)*	-0.303	(0.396)*	-0.201	-0.340	-0.358	-0.279	-0.218
Debt Ratio	0.031	0.015	0.049	0.004	0.027	-0.102	0.181	0.404
	-0.663	-0.125	-0.185	-0.056	-0.885	-0.887	-0.725	-0.286
Claims Ratio	0.036	-0.389	0.046	-0.101	0.010	0.010	0.004	-0.002
	-0.182	(0.123)***	-0.142	-0.076	(0.002)***	(0.002)***	(0.002)***	(0.001)*
Location	-0.002	0.025	-0.120	0.085	-0.163	-0.250	0.054	0.091
	-0.274	-0.197	-0.187	-0.072	(0.064)**	(0.071)***	-0.054	(0.045)**
Age	-0.001	-0.002	0.001	0.000	-0.002	-0.002	-0.001	-0.001
	-0.001	(0.001)**	-0.001	0.000	(0.001)**	(0.001)**	(0.001)*	-0.001
Size	0.023	0.084	-0.022	-0.057	0.003	0.017	-0.002	-0.032
	-0.033	(0.021)***	-0.027	(0.015)***	-0.019	-0.017	-0.014	(0.011)***
Year 1996	-0.070	-0.039	-0.029	0.009	-0.135	-0.162	-0.052	-0.402
	-0.076	-0.056	-0.074	-0.036	(0.067)**	(0.070)**	-0.061	(0.066)***
Year 1997	-0.131	-0.076	-0.074	-0.058	0.006	-0.027	0.011	0.039
	-0.081	-0.062	-0.081	-0.042	-0.070	-0.074	-0.065	-0.061
Year 1998	-0.195	-0.069	-0.121	-0.093	-0.004	-0.019	-0.007	-0.052
	(0.087)**	-0.071	-0.090	(0.043)**	-0.074	-0.075	-0.063	-0.060
Year 1999	-0.255	-0.051	-0.201	-0.043	-0.028	-0.057	-0.071	0.023
	(0.099)***	-0.077	(0.096)**	-0.053	-0.069	-0.078	-0.061	-0.062
Year 2000	-0.286	-0.067	-0.265	-0.015	-0.102	-0.176	-0.038	-0.057
	(0.106)***	-0.086	(0.102)***	-0.053	-0.072	(0.073)**	-0.063	-0.059
Year 2001	-0.312	-0.034	-0.302	0.005	-0.040	-0.174	0.108	0.112
	(0.106)***	-0.092	(0.098)***	-0.053	-0.071	(0.076)**	-0.071	(0.063)*
Year 2002	-0.337	-0.091	-0.270	0.099	-0.096	-0.176	0.034	-0.084
	(0.113)***	-0.096	(0.109)**	-0.061	-0.076	(0.075)**	-0.078	-0.067
Heteroscedasticity SIZE	-0.003	-0.087	0.160	-0.052	0.104	0.082	0.012	-0.131
	-0.061	-0.062	(0.058)***	(0.029)*	(0.036)***	(0.040)**	-0.047	(0.029)***
Sigma	0.317	0.468	0.076	0.215	0.064	0.089	0.214	1.596
	(0.162)*	(0.247)*	(0.037)**	(0.055)***	(0.035)*	(0.054)*	(0.151)***	(0.703)**
Pseudo R^2	0.427	0.575	0.473	0.509	0.456	0.502	0.481	0.470

6. Conclusions

This study has analyzed the dynamic development of efficiency in the German and UK life insurance markets both pre and post deregulation. By also taking a longer post deregulation time period into account, this study improves on existing studies by enabling a longer gestation period for deregulation to have an influence on competition and efficiency. In addition, by analyzing the comparability of the parametric and non-parametric measures of efficiency, concerns regarding a methodological dependent set of results are diminished.

Under a simple view of competition the highly regulated German industry was expected to experience a greater improvement in post deregulation efficiency than the under regulated and competitive UK market. The data does not lend strong support to these assumptions. First, there is a lack of evidence linking deregulation to improving efficiency levels, or the development of total factor productivity. Second, while UK intra industry efficiency is higher than Germany; an examination of the German and UK global frontier suggests that UK inter industry efficiency is and nearly always has been dominated by the Germans. Therefore, while competition in the UK appears to drive more firms towards the frontier, the UK frontier is less efficient than the German frontier.

Moreover, what is clear from an examination of total factor productivity is that technical efficiency gains in the UK and Germany have always been dominated by technological improvements; and it is this which may explain why Germany is able to be more productive than the UK. Moreover, the dynamic development of insurance market efficiency is strongly determined by the most efficient firms. A result which is mirrored in the European banking sector (Casu *et al.*, 2004).

These findings arguably support the view that price regulations provided German firms with the incentive to be on the efficient frontier. Generating a competition to be the most efficient. The ability to achieve efficiency gains may have enabled the German industry to outperform the deregulated UK market.

For policymakers the issue is clearly how to enable the frontier firms to improve, not how inefficient firms can catch-up. An appropriate policy should assist those leading companies in accessing pools of highly skilled labor; and developing deeper and more innovative capital markets. In this way, the supply of high quality inputs as instigators and enablers of technological improvements is effectively managed at an economy wide level.

With the weight of evidencing pointing towards technological improvements, future research should begin to explore not how fast the efficient frontier develops overtime, but what determines technological growth in the insurance industry. This study suggests that firms on the frontier and new industry entrants are worthy of further investigation in this regard.

References

Amel, D., Barnes, C., Panetta, F., and Salleo, C. (2004) "Consolidation and efficiency in the financial sector: A review of the international evidence". *Journal of Banking & Finance* 28: 2493-2519.

Bauer, P. W., Berger, A. N., Ferrier, G. D., and Humphrey, D. B. (1998) "Consistency conditions for regulatory analysis of financial institutions: A comparison of frontier efficiency methods". *Journal of Economics and Business* 50: 85-114.

Berger, A. N. (1993) "'Distribution free' estimates of efficiency in the US banking industry and tests of the standard distribution assumption". *Journal of Productivity Analysis* 4: 261-292.

Berger, A. N., and Humphrey, D. B. (1997) "Efficiency of financial institutions: International survey and directions for further research". *European Journal of Operational Research* 98: 175-212.

Boonyasai, T., Grace, M. F., and Skipper Jr., H. D. (2002) "The effect of liberalization and deregulation on life insurer efficiency". Working Paper No. 02-2, Center for Risk Management and Insurance Research, Georgia State University, Atlanta, GA.

Brockett, P. L., Cooper, W. W., Golden, L. L., Rousseau, J. J., and Wang, Y. (2005) "Financial intermediary versus production approach to efficiency of marketing distribution systems and organizaional structure of insurance companies". *Journal of Risk and Insurance* 72: 393-412.

Casu, B., Girardone, C., and Molyneux, P. (2004) "Productivity change in European banking: A comparison of parametric and non-parametric approaches". *Journal of Banking & Finance* 28: 2521-2540.

Coelli, T. (1996) "A guide to FRONTIER Version 4.1: A computer program for stochastic frontier production and cost function estimation". CEPA Working paper 96/07.

Cummins, J. D., and Rubio-Misas, M. (2006) "Deregulation, consolidation, and efficiency: evidence from the Spanish insurance industry". *Journal of Money, Credit, and Banking* 38: 323-355.

Cummins, J. D., Turchetti, G., and Weiss, M. A. (1996) "Productivity and Technical Efficiency in the Italian Insurance Industry". Working paper, Wharton Financial Institution Centre, University of Pennsylvania, Philadelphia.

Cummins, J. D., and Weiss, M. A. (1999) "Analysing firm performance in the insurance industry using frontier efficiency and productivity methods," in Dionne, G. (ed.) *Handbook of Insurance*. G. Boston: Kluwer, 767-829.

Cummins, J. D., and Zi, H. (1998) "Measuring cost efficiency in the U.S. life insurance industry: Econometric and mathematical programming approaches". *Journal of Productivity Analysis* 10: 131-150.

Diacon, S. R., Starkey, K., and O' Brien, C. (2002) "Size and efficiency in European long-term insurance companies: An international comparison". *Geneva Papers on Risk and Insurance: Issues and Practice* 27: 444-466.

Dietsch, M., and Lozano-Vivas, A. (2000) "How the environment determines banking efficiency: A comparison between French and Spanish industries". *Journal of Banking & Finance* 24: 985-1004.

Doherty, N. A. (1981) "The measurement of output and economies of scale in proporty-liability insurance". *Journal of Risk and Insurance* 48: 390-402.

Färe, R., Grosskopf, S., and Lovell, C. A. K. (1994) *Production Frontiers*. Cambridge.: Cambridge University Press.

GDV Yearbook (2003) *The German insurance industry*. Berlin, Germany: Gesamtverband der Deutschen Versicherungswirtschaft e.V. (GDV).

Grenham, D. J., Chakraborty, D. C., Chatterjee, A., Daelman, P. J., Heistermann, B., Hogg, L., Mungall, J. R., Porteous, B. T., Richards, S. J., Shum, M. C., and Taylor, J. (2000) "International expansion - a United Kingdom perspective". *British Actuaries Journal* 6: 3-54.

Hardwick, P. (1997) "Measuring cost inefficiency in the UK life insurance industry". *Applied Financial Economics* 7: 37-44.

Hattori, T., Jamasb, T., and Pollitt, M. (2005) "Electricity distribution in the UK and Japan: a comparative efficiency analysis 1985-1998". *The Energy Journal* 26: 23-47.

Hoff, A. (2006) "Second stage DEA: Comparison of approaches for modelling the DEA score". *European Journal of Operational Research In Press*, Corrected Proof.

Hogan, A. M. B. (1995) "Regulation of the Single European insurance market". *Journal of Insurance Regulation* 13: 329-358.

International Monetary Fund (2003) *International Financial Statistics* August 2003. Washington: International Monetary Fund.

Khaled, M., Adams, M. B., and Pickford, M. (2001) "Estimates of scale and scope economies in the New Zealand life insurance industry". Manchester School 69, 327-349.

Kielholz, W. (2000) "The cost of capital for insurance companies". *Geneva Papers on Risk and Insurance: Issues and Practice* 25: 4-24.

Mahlberg, B., and Url, T. (2000) *The transition to the single market in the German insurance industry*. Working paper, Vienna University of Economics and Business Administration, Vienna, Austria.

OECD (2003) *Insurance Statistics Yearbook* 1994/2001. Paris, France: OECD.

Rees, R., and Kessner, E. (1998) ″Regulation and efficiency in European insurance markets". *Economic Policy* 14: 365-392.

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.

Swiss Re (2001) *Profitability of the non-life insurance industry: It's back-to-basics time.* Sigma No.5/2001.

Swiss Re (2005) *World insurance in 2004: Growing premiums and stronger balance sheets.* Sigma No.2/2005.

Uri, N. D. (2002) "Assessing the effect of incentive regulation on productive efficiency in telecommunications in the United States". *European Journal of Law and Economics* 13: 113-127.

Ward, D. (2002) "The costs of distribution in the UK life insurance". *Applied Economics* 34: 1959-1968.

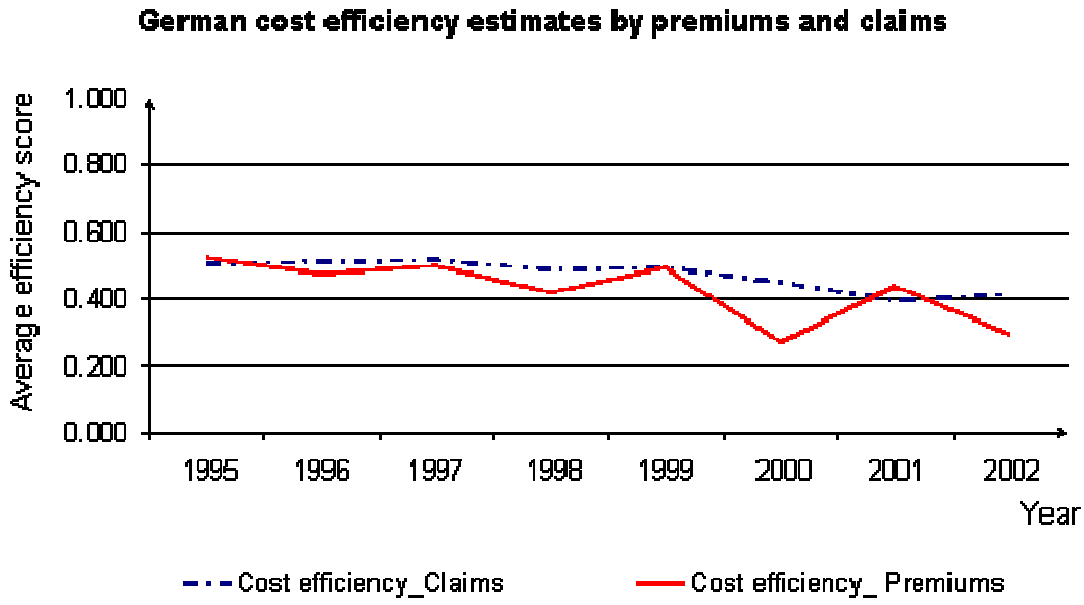
Ward, D. R. (1997) "Sales Force Training and Turnover". *Risk Decision and Policy 2*, 181-192.

Weill, L. (2004) "Measuring cost efficiency in European banking: A comparison of frontier techniques". *Journal of Productivity Analysis* 21: 133-152.

Yuengert, A. (1993) "The measurement of efficiency in life insurance: Estimates of a mixed normal gamma error model". *Journal of Banking & Finance* 17: 483-496.

Appendices

Figure A1: German and UK cost efficiency estimates by premiums and claims



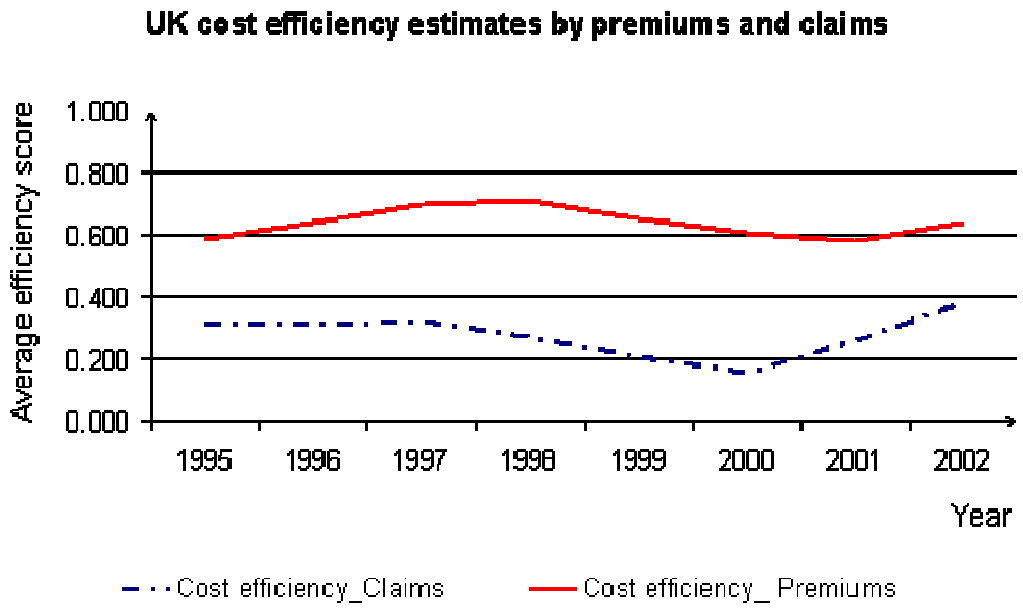


Table A1: Spearman rank coefficients (claims vs. premiums)

1995

	Germany	te_claims	ae_claims	ce_claims
	te_premium	.851(**)		
1996	ae_premium		.944(**)	
	ce_premium			.938(**)

1996

	Germany	te_claims	ae_claims	ce_claims
	te_premium	.913(**)		
1996	ae_premium		.951(**)	
	ce_premium			.973(**)

1997

	Germany	te_claims	ae_claims	ce_claims
	te_premium	.789(**)		
1997	ae_premium		.917(**)	
	ce_premium			.939(**)

1998

	Germany	te_claims	ae_claims	ce_claims
	te_premium	.886(**)		
1998	ae_premium		.959(**)	
	ce_premium			.935(**)

1995

	UK	te_claims	ae_claims	ce_claims
	te_premium	.781(**)		
1996	ae_premium		.432(**)	
	ce_premium			.681(**)

1996

	UK	te_claims	ae_claims	ce_claims
	te_premium	.832(**)		
1996	ae_premium		.824(**)	
	ce_premium			.846(**)

1997

	UK	te_claims	ae_claims	ce_claims
	te_premium	.852(**)		
1997	ae_premium		.659(**)	
	ce_premium			.642(**)

1998

	UK	te_claims	ae_claims	ce_claims
	te_premium	.813(**)		
1998	ae_premium		.843(**)	
	ce_premium			.796(**)

1999

	Germany	te_claims	ae_claims	ce_claims
	te_premium	.892(**)		
1999	ae_premium		.948(**)	
	ce_premium			.962(**)

2000

	Germany	te_claims	ae_claims	ce_claims
	te_premium	0.241		
2000	ae_premium		.965(**)	
	ce_premium			.827(**)

2001

	Germany	te_claims	ae_claims	ce_claims
	te_premium	.807(**)		
2001	ae_premium		.961(**)	
	ce_premium			.878(**)

2002

	Germany	te_claims	ae_claims	ce_claims
	te_premium	.772(**)		
2002	ae_premium		.943(**)	
	ce_premium			.881(**)

1999

	UK	te_claims	ae_claims	ce_claims
	te_premium	.857(**)		
1999	ae_premium		.808(**)	
	ce_premium			.674(**)

2000

	UK	te_claims	ae_claims	ce_claims
	te_premium	.708(**)		
2000	ae_premium		.745(**)	
	ce_premium			.627(**)

2001

	UK	te_claims	ae_claims	ce_claims
	te_premium	.738(**)		
2001	ae_premium		.552(**)	
	ce_premium			.727(**)

2002

	UK	te_claims	ae_claims	ce_claims
	te_premium	.503(**)		
2002	ae_premium		-0.107	
	ce_premium			0.103

Notes:

te = Technical efficiency
ae = Allocative efficiency
ce = Cost efficiency
** = Correlation is significant at the 0.01 level (2-tailed).
* = Correlation is significant at the 0.05 level (2-tailed).

Table A2: Spearman rank coefficients for pooled German and UK data with and without 5% truncation at the upper and lower end.

		1991		
		te_all	ae_all	ce_all
1991	te_trunc	.940(**)		
	ae_trunc		.872(**)	
	ce_trunc			.960(**)

		1997		
		te_all	ae_all	ce_all
1997	te_trunc	.911(**)		
	ae_trunc		.896(**)	
	ce_trunc			.909(**)

		1992		
		te_all	ae_all	ce_all
1992	te_trunc	.921(**)		
	ae_trunc		.710(**)	
	ce_trunc			.857(**)

		1998		
		te_all	ae_all	ce_all
1998	te_trunc	.934(**)		
	ae_trunc		.812(**)	
	ce_trunc			.952(**)

		1993		
		te_all	ae_all	ce_all
1993	te_trunc	.986(**)		
	ae_trunc		.850(**)	
	ce_trunc			.944(**)

		1999		
		te_all	ae_all	ce_all
1999	te_trunc	.990(**)		
	ae_trunc		.823(**)	
	ce_trunc			.995(**)

		1994		
		te_all	ae_all	ce_all
1994	te_trunc	.956(**)		
	ae_trunc		.843(**)	
	ce_trunc			.971(**)

		2000		
		te_all	ae_all	ce_all
2000	te_trunc	.995(**)		
	ae_trunc		.947(**)	
	ce_trunc			.997(**)

		1995		
		te_all	ae_all	ce_all
1995	te_trunc	.985(**)		
	ae_trunc		.809(**)	
	ce_trunc			.987(**)

		2001		
		te_all	ae_all	ce_all
2001	te_trunc	.944(**)		
	ae_trunc		.822(**)	
	ce_trunc			.945(**)

		1996		
		te_all	ae_all	ce_all
1996	te_trunc	.921(**)		
	ae_trunc		.866(**)	
	ce_trunc			.946(**)

		2002		
		te_all	ae_all	ce_all
2002	te_trunc	.986(**)		
	ae_trunc		.875(**)	
	ce_trunc			.990(**)

Notes:

te = Technical efficiency
ae = Allocative efficiency
ce = Cost efficiency
trunc = The pooled dataset truncated at the top and bottom 5%.
all = The whole pooled dataset , N=78.
** = Correlation is significant at the 0.01 level (2-tailed).
* = Correlation is significant at the 0.05 level (2-tailed).