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Size and Efficiency in European Long-term Insurance Companies: An International Comparison

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1. Introduction

The implementation of the single insurance licence within the European Union in 1994 provided insurers licensed in the E.U. with the opportunity to transact long-term insurance business in any E.U. state, either by starting up a subsidiary or branch, or by direct sale. This E.U.-wide insurance market has also been extended to countries within the European Economic Area (e.g. Norway) and the European Free Trade Association (e.g. Switzerland). Thus companies transacting long-term insurance business now potentially compete in a European-wide market.[1] It is not surprising, therefore, that there is growing interest and concern about the international competitiveness and efficiency of European insurers.

The concept of efficiency concerns an insurer's ability to produce a given set of outputs (such as premiums and investment income) via the use of inputs such as administrative and sales staff and financial capital. An insurer is said to be technically efficient if it cannot reduce its resource usage without some corresponding reduction in outputs, given the current state of production technology in the industry.

This paper attempts to build on earlier attempts by Rai (1996), Donni and Fecher (1997), and Katrishen and Scordis (1998) to undertake an international comparison of the efficiency of companies transacting long-term insurance (i.e. life, pensions, and health business). International comparisons of efficiency are crucial as efficiency is a relative concept: it is not possible to define some "ideal" level of efficiency; instead, companies have to be compared with those that currently constitute best practice in the market (given the current state of production technology in the industry). The paper looks at three different measures of value-based efficiency: pure technical efficiency (which is concerned with the optimal use of resources to produce output), scale efficiency (the extent to which the insurer is affected by either increasing or decreasing returns to scale), and mix efficiency (whether the insurer is utilizing an ideal combination of inputs and outputs).

An exploration of the value-based technical efficiency of long-term insurers is undertaken by comparing the relative performance of approximately 450 insurers licensed in 15 European countries using data from Standard & Poor's *Eurothesys* database. The data has been made available on a (roughly) comparable basis as a result of the E.U. Insurance Accounts Directive, which only came fully into operation in 1996. The efficiency analysis uses the variable returns to scale formulation of the well-known data envelopment model to compute the pure technical, scale and mix efficiencies of each insurer relative to a European

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[1] A brief review of the European insurance industry can be found in Rassam (1998).

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efficiency frontier for each year between 1996 and 1999. A key contribution of this study is also to identify the best practice companies operating in the European long-term insurance market, and then to benchmark all other insurers against these.

It has been widely recognized that inter-firm differences in efficiency can arise due to environmental factors, some of which will be country-specific, and the study also explores two aspects of such differences. First, the inter-country differences in average insurer efficiency are examined to determine the extent to which local operating conditions and regulations can cause insurers to be disadvantaged in particular local environments. Second, a regression analysis is undertaken to explore the differences in efficiency between firms in order to determine the extent to which such differences can be explained by organization size, structure and risk.

This paper is organized as follows. Section 2 provides a brief review of the issues involved in the measurement of value-based technical efficiency and discusses the problems in applying these measures to insurance and other financial services firms. Section 3 then describes the application of Data Envelopment Analysis (DEA) to insurance companies licensed to transact long-term insurance business in 15 European markets (namely Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, Sweden, Switzerland and the U.K.). The results are tabulated and reviewed in sections 4 and 5, and the final section provides some discussion and conclusions.

2. A brief overview of efficiency and measurement

The concept of efficiency concerns an insurer's ability to produce a given set of outputs (such as premiums and investment income) via the use of inputs such as administrative and sales staff and financial capital. An insurer is said to be technically efficient if it cannot reduce its resource usage without some corresponding reduction in outputs, given the current state of production technology in the industry.

Technical inefficiencies can arise from a variety of sources. Companies which are operating at an inappropriate size (either too large or too small) may display what are termed "scale inefficiencies", while others may be utilizing their inputs (or producing their outputs) in the wrong proportions ("mix inefficiencies"). All companies have to contend with environmental factors that may damage their ability to operate efficiently; others may simply be badly managed. A detailed discussion of the potential sources of insurer inefficiency can be found in Cummins and Santomero (1999) and Cummins, Weiss and Zi (1999).

Traditionally analysts have analysed the efficiency of organizations (or decision-making units – DMUs) by focusing on certain simple ratios such as labour productivity (output per unit of labour employed) or capital intensification (i.e. capital/labour). Similarly the efficiency of insurance firms has often been measured by key ratios such as the expenses and claims ratios, the solvency margin, and the return on invested assets. There are, however, a number of problems associated with a simplistic multiple-ratio analysis.

- It is generally impossible to identify best practice DMUs since it is unlikely that all ratios will point to the same firm(s);
- If the ratios disagree, it may be difficult to decide in advance which ratio should be given most weight in order to compare DMUs;
- Efficiency comparisons should properly be made on the basis of like-for-like so that inefficient firms are identified because, in some way, they are inferior to other *similar* DMUs;

- The traditional measures do not readily allow firms to identify the source of any inefficiency.

More modern approaches to efficiency and benchmarking try to circumvent the problems associated with traditional methods by using frontier efficiency methodologies. Essentially, the various methods proceed by first identifying "best practice" frontiers (and the DMUs which lie nearest to these frontiers). The frontier represents the best performance that can be achieved using the currently available production technology. By definition, a DMU which is part of the frontier set uses a minimum amount of inputs in order to achieve any given level of contemporaneous outputs. The efficiency of each DMU can then be measured by comparing it to the "frontier" firms that are nearest to it. Perhaps the best known such measure of efficiency is the input-orientated Farrell measure which defines a DMU's technical efficiency as the proportion by which all inputs need to be reduced *in proportion* in order to adopt the most efficient production (Farrell, 1957).[2]

The widespread practice of using value measures (such as revenue, costs, capital) as proxies for the inputs and outputs of financial services firms raises questions about exactly what type of efficiency is being measured. Technical efficiency strictly requires inputs and outputs to be measured in units, while the optimal allocation of inputs/outputs in response to market prices (*allocative efficiency*) requires separate data on input and output prices and quantities, in order to compare the actual versus the cost-minimizing (revenue-maximizing) level of inputs (outputs). However, the intangible nature of financial services output often means that no homogeneous unit of output can be identified (sometimes even conceptually) and output prices cannot be quality adjusted. Similarly inputs like capital can only exist in value terms, and the unit cost of capital is difficult to measure in firms that are not publicly quoted. Thus the technical efficiencies reported here are *value-based* rather than the more traditional units-based measures found in many non-financial efficiency studies.[3]

Data envelopment analysis (DEA) is a non-parametric frontier method that uses linear programming techniques to discover the frontier firms and construct a convex piece-wise linear surface or frontier over these firms. In terms of technical efficiency, the most efficient firms are those with the largest value (over all firms) of the ratio of the weighted sum of outputs to the weighted sum of inputs, where the optimal weights for each firm maximizes that particular firm's ratio. Non-parametric methods have the advantage of not having to specify the form of the production function or error distribution and can also handle multiple outputs as well as multiple inputs. On the other hand, non-parametric frontiers do not normally have any stochastic component, so that any departure from the frontier must be categorized as inefficiency.[4]

Although there are a variety of ways of computing an efficiency frontier, it is important to identify the returns to scale characteristics which are embedded in the choice of frontier.

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[2] The term "technical efficiency" refers explicitly to the utilization of units of input to produce units of output without any allowance for input prices (to compute costs) or output prices (to compute revenues). Explicit allowance for input and output prices may enable an analysis of allocative (by exploring cost minimization) and economic efficiency (by examining revenue maximization): for further details see Coelli, Rao and Battese (1998, ch. 7).

[3] The term "value-based" is used to recognize that the technical efficiency measures are based on monetary values for inputs and outputs (using both cost/revenue flows, and capital stocks), but do not capture optimal choices in response to market prices.

[4] A detailed comparison of parametric and non-parametric frontier methods is provided by Coelli *et al.* (1998), while Cummins and Zi (1998) apply the different methods to explore the efficiency of U.S. life insurance firms.

Constant returns to scale (CRS) arise when a percentage increase in (all) inputs produces the same percentage increase in outputs, whereas decreasing (increasing) returns to scale occur when a proportionate increase in inputs produces a smaller (larger) proportionate increase in outputs.[5] Efficiency frontiers which allow returns to scale to vary according to the scale of inputs are known as variable returns to scale (VRS) frontiers. The VRS version recognizes that firms may not be operating at their optimal scale of production, and produces a frontier which has increasing returns to scale at low input levels and decreasing returns to scale at high input levels. In essence, this means that inefficient firms are only compared to others that are more or less the same size.

Although the choice and inputs and outputs is fundamental to the success of any efficiency analysis, it has proved to be problematic in the case of financial services firms. Particular difficulties can arise in classifying intermediate goods and services, which can have both input and output characteristics. In general, inputs such as land, labour and capital represent the resources that are utilized to produce the firm's output, and the acquisition of these inputs represents a cost to the firm. Outputs, on the other hand, represent those goods or services which the customers of the firm are prepared to purchase, and the sale of these outputs generates revenue. Cooper, Seiford and Tone (2000) comment that *ceteris paribus* DMUs should generally prefer smaller inputs and larger outputs, and that this relationship should be reflected in the efficiency scores. The management of the DMU should be able to control either inputs and/or outputs in order to improve efficiency.

For financial services companies such as banks and insurers, the output is often intangible and therefore difficult to measure (and control). The pragmatic approach is therefore to identify the services provided by such firms and find measurable proxies that are highly correlated with these services.[6] Financial service firms not only deal with identifiable inputs and outputs, but also in unknown elements of risk. A key part of the success of banks and insurers may be due to their effectiveness in risk management and Berger and Humphrey (1997) report several studies that have found a positive relationship between risk and efficiency.

There has been considerable disagreement over the appropriate proxies to use for the output of insurance services.[7] When it comes to considering insurance company output, the majority of efficiency studies have used premium income as a proxy for the output (of non-investment-related) insurance services even though premiums are really a form of revenue, that is price times quantity rather than a count of output units (Yuengert, 1993).[8] There are also issues concerning whether premiums should be net or gross or reinsurance (Brown,

[5] The firm(s) on an efficiency frontier that allows for only CRS will be the ones which have the greatest output per unit input whatever their scale of inputs. Firms not on the CRS frontier will be inefficient either because they are technically inefficient (arising from a poor use of resources) or because they are operating at an inappropriate scale (scale inefficiency).

[6] Berger and Humphrey (1997) describe two main ways of conceptualizing the flow of services produced by a financial services firm: the "production" service views financial firms as producing services for customers, while the "intermediation" service is to intermediate funds between savers and investors. Cummins and Santomero (1999) discuss the nature of insurance company services, making the usual categorization: risk-financing, pooling and transfer, investment, and real services and advice.

[7] A further, but largely unresolved problem, arises because insurance inputs and outputs rarely take place contemporaneously; for example, in some classes of business, input resources are utilized substantially in advance of the "production" of insurance services (e.g. the payment of claims).

[8] The problems associated with using premium income as a proxy for output are discussed in detail in Diacon (1990, ch. 10).

2000), and calculated on a cash flow (written) or accruals (earned) basis. The latter issue can be particularly important in life and pensions business and long-tailed general insurance business where there is a substantial delay between the collection of premiums and the payment of claims. Investment income is often used to proxy for the investment-related services provided by insurers (since again there is no available count of investment units).

The problems with using premium income to proxy output have led some authors to use the value of benefits payments instead.[9] However it is difficult to understand why the management of insurance companies would seek to maximize the value of insurance claims (particularly for general insurance), and this therefore violates the principle output characteristic identified by Cooper *et al.* (2000) that more output should be preferred to less.[10]

When it comes to the choice of inputs, there is general agreement that labour (administrative, managerial and sales) and capital are the main input resources utilized in the production of insurance. Although it may be possible to undertake a head-count of staff, most studies use total operating and selling costs as a proxy. In the insurance industry, this approximation is a necessity because of the widespread industry practice of outsourcing administrative and sales functions (so that a simple headcount would seriously underestimate staff inputs).

3. Data and methodology

Sample selection and characteristics

Sample data is obtained from the Standard & Poor's *Eurothesys* 1996–1999 database of specialist long-term and composite insurance companies licensed in 15 European countries. The Standard & Poor's database contains information drawn from the annual consolidated report and accounts filed to the respective registrar of companies in each country. The sample therefore contains a mixture of consolidated groups (such as the AXA SA Group in France – Europe's largest company in terms of long-term net earned premium) and local subsidiaries (such as AXA Equity & Law, Sun Life & Provincial, Guardian Royal Exchange, and PPP Healthcare – all of which are fully owned subsidiaries of AXA operating in the U.K.). Companies are excluded from the sample if it was obvious that their results were consolidated into another insurer *in the same* country unless they appeared to be trading as a separate unit. Companies are also excluded if they had non-positive values for total assets, total technical reserves, total capital, total operating expenses, total investment income, long-term gross written premium or long-term net earned premium. Some companies were affected by corporate restructuring over the period, and are only included if they had meaningful values for capital and technical reserves in the previous year.

In the 1999 dataset, for example, a total of 454 companies are included: Austria (10), Belgium (22), Denmark (26), France (62), Germany (103), Greece (3), Ireland (5), Italy (35), Luxembourg (5), The Netherlands (19), Portugal (13), Spain (16), Sweden (21), Switzerland (16) and the U.K. (98).

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[9] For example Cummins and Weiss, 1993; Berger, Cummins and Weiss, 1997; Cummins and Zi, 1998; Cummins, Tennyson and Weiss, 1999; Cummins, Weiss and Zi, 1999; Cummins and Santomero, 1999.

[10] Furthermore the time lag in the payment of claims means that accounting entries for insurance losses accrued (i.e. claims incurred) involve a substantial element of estimation and year-on-year readjustment. Using the long-term benefits paid in any one year really reflects the activities of the insurer over many preceding years rather than the current one.

Choice of inputs and outputs

This study uses staff and capital resources as the main inputs, and premiums and investment income as the main outputs. The inputs of sales, administrative and managerial staff are proxied by the insurer's total operating expenses and commissions. Capital inputs are split between shareholders' capital and reserves, technical provisions, and debt – all measured at the start of the financial year. Premium and investment income are used to represent output as it is felt that these revenue measures are the available best proxies of the services that insurers provide to their customers. No explicit measures of risk have been used for either input or output: instead, the resulting efficiency scores are regressed against risk variables using an econometric approach in section 4.

Details of the four input and three output variables covering the European insurers' worldwide long-term and general business are given in the following boxes:

Inputs	
TOTOPEX	Total operating expenses, net of reinsurance commissions, from the general and long-term technical accounts and the non-technical account.
CAPLAG	Total capital (including shareholders' capital, capital and reserves, participating rights capital, special untaxed reserves, minority interests, subordinated liabilities, subordinated debt, and the long-term fund for future appropriations) at start of year.
TECHLAG	Total technical reserves for general, and linked and unlinked long-term business at start of year.
CREDLAG	Total borrowings from creditors at start of year.

Outputs	
GNEP	General insurance net earned premiums, less rebates and refunds.
LTNEP	Long-term insurance net earned premiums, less rebates and refunds.
TOTINV	Total investment income from all technical and non-technical accounts, including realized and unrealized capital gains and losses, net of investment expenses and charges.

A summary of inputs and outputs is provided in Table 1 for 1999. All values have been converted into U.S.$ million at year-end exchange rates. A simple breakdown of the relative performance of European insurers in 1999 is illustrated in Figure 1 (based on the figures in Table 1).

Measures of efficiency: pure technical, scale and mix

Efficiency estimates are obtained by using the input-orientated variable returns to scale (VRS) formulation of data envelopment analysis (DEA), the best-known non-parametric frontier method pioneered by Banker, Charnes and Cooper (1983). All efficiency estimates are produced using the DEA-Solver Software of Cooper *et al.* (2000). Three different aspects of efficiency are considered:

Table 1:
Outputs and inputs of insurers transacting long-term business, 1999, U.S.$ million

Country		GNEP	LTNEP	TOTINV	TOTOPEX	CAPLAG	TECHLAG	CREDLAG
Austria	Mean	192.166	195.064	120.731	95.705	147.386	1741.293	59.373
10	Std Dev	377.033	212.223	170.697	153.977	259.878	2163.977	109.013
	Minimum	0.000	4.842	7.320	8.888	19.560	76.889	2.490
	Maximum	1237.513	572.298	566.462	522.642	877.000	6945.356	364.644
Belgium	Mean	390.165	539.412	403.112	210.437	557.990	3512.801	294.121
22	std Dev	1177.440	1491.193	1234.106	688.232	1878.440	11387.753	956.601
	Minimum	0.000	0.016	5.763	0.045	4.714	31.863	6.562
	Maximum	5521.571	7061.937	5755.228	3251.605	8907.841	54065.847	4511.156
Denmark	Mean	107.321	194.798	425.728	47.132	356.540	3067.986	69.090
26	Std Dev	244.562	291.339	685.441	88.217	420.617	5249.386	126.776
	Minimum	0.000	4.115	6.305	0.189	1.415	2.954	0.123
	Maximum	769.346	1271.991	2562.733	318.639	1306.478	20018.996	479.909
France	Mean	734.039	1949.998	935.196	420.085	1160.853	16399.460	1693.264
62	Std Dev	2252.401	5123.920	2199.167	1361.396	3461.157	42241.373	9073.744
	Minimum	0.000	0.545	0.508	0.062	0.354	9.179	0.079
	Maximum	14937.554	36814.492	14697.469	9285.995	25881.439	308536.601	71198.124
Germany	Mean	745.060	1094.322	798.958	536.074	920.788	10656.461	1300.653
103	Std Dev	3237.939	2251.439	2143.436	2000.056	4502.360	30907.039	5243.648
	Minimum	0.000	1.972	0.188	0.607	1.170	0.810	0.068
	Maximum	29256.009	17135.997	18513.627	18333.613	40306.622	274090.144	48901.348
Greece	Mean	31.668	46.860	42.881	24.669	25.795	94.780	25.898
3	Std Dev	48.683	75.264	45.177	20.574	18.537	73.794	25.092
	Minimum	0.945	3.286	3.693	1.067	6.880	9.726	3.401
	Maximum	87.798	133.767	92.295	38.810	43.930	141.788	52.959

Ireland	Mean	53.214	205.904	137.440	39.506	203.373	1095.835	31.353
5	Std Dev	118.989	210.433	114.833	32.555	142.916	804.609	26.384
	Minimum	0.000	6.796	3.207	4.419	10.499	21.639	1.393
	Maximum	266.068	501.607	283.336	80.435	340.204	1792.123	61.839
Italy	Mean	819.613	1436.002	870.581	446.299	745.651	8116.291	492.774
35	Std Dev	2252.065	3925.137	3251.817	1388.222	1661.588	25325.207	1649.265
	Minimum	0.000	18.133	2.869	1.760	10.223	74.517	3.141
	Maximum	12471.401	23418.911	19211.885	8053.421	7988.186	149469.612	9512.496
Luxembourg	Mean	24.316	333.479	147.399	26.703	3164.234	8212.871	883.239
5	Std Dev	54.373	228.289	105.161	15.976	6997.153	15659.576	1941.336
	Minimum	0.000	37.461	25.430	6.079	15.818	257.785	4.268
	Maximum	121.582	586.149	314.066	45.787	15681.073	36198.483	4355.950
Netherlands	Mean	588.358	2388.096	2277.532	526.184	3629.083	18914.601	2531.365
19	Std Dev	887.728	4650.808	4792.481	922.529	6748.943	33879.523	4330.105
	Minimum	0.000	7.652	58.252	19.623	105.006	716.621	38.299
	Maximum	3345.128	17974.288	19406.766	3097.006	25929.774	121377.747	14535.763
Portugal	Mean	150.074	310.902	100.716	60.855	294.653	1145.734	80.481
13	Std Dev	129.839	312.129	145.653	52.241	406.873	997.408	78.964
	Minimum	0.000	9.220	1.643	1.270	12.551	67.428	0.587
	Maximum	348.577	894.360	517.304	146.587	1470.601	2996.628	227.346
Spain	Mean	372.372	474.645	184.473	133.905	266.784	2382.365	251.118
16	Std Dev	765.811	563.980	131.630	245.475	409.245	1708.831	368.474
	Minimum	0.000	1.686	5.790	1.262	22.045	85.517	7.145
	Maximum	2760.109	1932.395	470.922	830.479	1540.796	6174.389	1430.364
Sweden	Mean	34.497	984.788	1876.096	94.229	3352.160	5666.795	387.185
21	Std Dev	94.134	2347.565	3112.682	221.534	5600.259	9761.393	782.289
	Minimum	0.000	0.511	0.148	0.173	4.104	1.263	0.008
	Maximum	353.841	10800.800	11404.533	1026.123	19338.097	39245.240	3199.528

continued overleaf

Table 1:
(continued)

Country		GNEP	LTNEP	TOTINV	TOTOPEX	CAPLAG	TECHLAG	CREDLAG
Switzerland	Mean	1980.285	2088.446	1462.606	1082.094	2986.971	22520.019	2389.906
16	Std Dev	4396.706	3353.538	2671.381	2356.207	5862.239	41755.170	5452.026
	Minimum	0.000	21.578	10.859	5.621	34.604	270.818	10.773
	Maximum	16987.000	9635.489	9660.000	9333.000	22994.000	152796.000	21193.000
U.K.	Mean	433.600	1516.465	2220.176	366.110	2691.325	12607.669	826.702
98	Std Dev	1940.024	3234.324	4556.475	956.995	6163.644	26582.203	2444.709
	Minimum	0.000	0.286	0.435	0.331	2.346	3.969	0.000
	Maximum	14483.276	23844.062	27157.758	6713.063	40137.314	144968.765	19065.557
Total	Mean	569.837	1245.185	1148.356	379.297	1523.866	10455.962	991.750
454	Std Dev	2264.355	3167.699	3024.094	1334.961	4544.924	28309.366	4588.089
	Minimum	0.000	0.016	0.148	0.045	0.354	0.810	0.000
	Maximum	29256.009	36814.492	27157.758	18333.613	40306.622	308536.601	71198.124

Key
TOTOPEX Total Operating Expenses
CAPLAG Total Capital at start of year
TECHLAG Total Technical Reserves at start of year
CREDLAG Total Borrowing from Creditors at start of year
GNEP General Net Earned Premium Income
LTNEP Long-term Net Earned Premium Income
TOTINV Total Investment Income

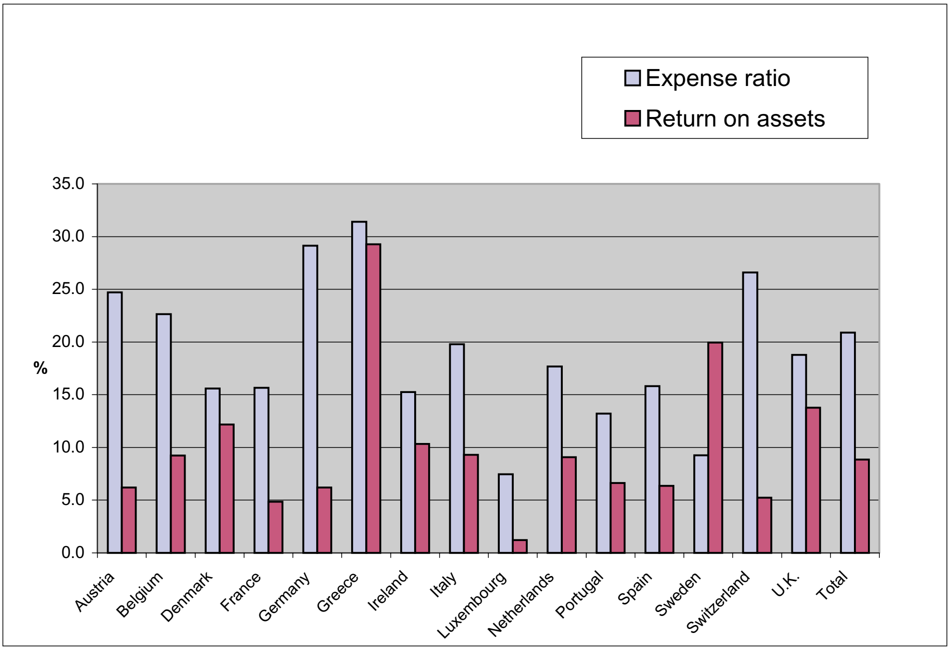

Figure 1: Performance of European long-term insurers, 1999

- *Pure technical efficiency*: This measures the extent to which a firm can decrease its inputs (in fixed proportion) while still remaining within the VRS frontier. Thus technical efficiency measures the DMU's overall success at utilizing its inputs.
- *Scale efficiency*: This reflects the extent to which a firm projected to the VRS efficiency frontier can further decrease its inputs (again in fixed proportions) while still remaining within the constant returns to scale frontier. Thus scale efficiency measures the extent to which a firm can reduce inputs by moving to a part of the frontier with more beneficial returns to scale characteristics.
- *Mix efficiency*: This measures the extent to which a firm projected onto the VRS frontier can further decrease some inputs without decreasing outputs (or increase output without increasing inputs). Thus mix efficiency measures the extent to which a DMU can benefit from a change in the balance of its inputs and outputs.[11]

4. Efficiency scores of European life insurers

The analysis of efficiency of European life insurers is undertaken over the four years, 1996–1999. Over that period, the European insurance industry has experienced considerable

[11] Cooper *et al.* (2000) suggest that a non-Farrell measure of mix efficiency can be computed as: $\rho = \{1 - \text{Average}(s^-/\text{Input})\}/\{1 + \text{Average}(s^+/\text{Output})\}$. This measure lies on the (0,1] interval: a value of unity implies that the firm is fully mix efficient, since all input and output slacks (s^- and s^+) will then be zero.

rationalization, and that is reflected in the number of companies included in the study: Table 2 shows that the total number of companies analysed fell from 639 in 1996 to 454 in 1999. Some countries have experienced a striking reduction; for example, the number of competing companies in Belgium, Ireland, the Netherlands and Spain more than halved over the four-year period.

Table 3 illustrates the average efficiency scores for each of the European long-term insurance markets, for the years 1996–1999, while further time-related features are pictured in Figures 2 and 3. The last line of Table 3 and Figure 2 show the development of the average European-wide efficiency scores: in general, it would appear that the average level of pure technical efficiency has declined since 1996. This is a slightly surprising feature, as any technical progress should exhibit improvements over time. On the other hand, average scale and mix efficiencies both increased between 1996 and 1998, only to decline sharply in 1999. Although there are a number of possible explanations for this observed pattern, it is probably related to disruption associated with the rationalization (mergers and reorganizations) illustrated in Table 2.

Figure 3 and Table 3 provide evidence of substantial variations in international efficiency. Over the four-year period, the Nordic insurers of Sweden and Denmark demonstrate a consistently high level of technical efficiency, although this may be due to the specialist nature of their occupational pensions companies (e.g. "Pensionskassen" in Denmark). Spain and the U.K. also show higher-than-average levels of technical efficiency over the period. A more detailed picture of the sources of such international efficiency differences will emerge when inter-company differences are explored in more detail.

Table 4 illustrates the average reductions in inputs and expansion in outputs necessary to project insurers to their global efficiency frontiers for each year. The projected values take

Table 2:
Number of sampled insurers, 1996–1999

	1996	**1997**	**1998**	**1999**
Austria	13	13	12	10
Belgium	44	45	36	22
Denmark	31	31	30	26
France	82	88	84	62
Germany	117	123	105	103
Greece	3	3	3	3
Ireland	14	11	13	5
Italy	49	49	43	35
Luxembourg	8	9	7	5
Netherlands	35	36	25	19
Portugal	20	20	20	13
Spain	42	43	38	16
Sweden	19	21	21	21
Switzerland	26	25	19	16
U.K.	136	132	121	98
Total	639	649	577	454

Table 3:
Average efficiency scores by country, 1996–1999. Insurers transacting long-term business

	Technical				**Scale**				**Mix**			
	1996	**1997**	**1998**	**1999**	**1996**	**1997**	**1998**	**1999**	**1996**	**1997**	**1998**	**1999**
Austria	0.5577	0.4408	0.4908	0.4475	0.9444	0.9738	0.9669	0.8811	0.8510	0.9743	0.9840	0.9435
Belgium	0.5375	0.4188	0.5411	0.5408	0.9158	0.9463	0.9152	0.8332	0.7929	0.8588	0.9081	0.8690
Denmark	0.6714	0.6056	0.6184	0.6810	0.9140	0.9218	0.9157	0.8173	0.8975	0.8417	0.9483	0.6897
France	0.6023	0.4423	0.4526	0.4394	0.7713	0.8181	0.8453	0.6356	0.8773	0.9248	0.9484	0.8476
Germany	0.7109	0.4391	0.5540	0.4911	0.6490	0.8164	0.8878	0.6870	0.8898	0.8819	0.9617	0.8650
Greece	0.5363	0.3496	0.4372	0.6785	0.8428	0.9509	0.8419	0.5966	0.5896	0.7678	0.8007	0.6132
Ireland	0.6417	0.4796	0.6504	0.3055	0.8177	0.9130	0.9414	0.5042	0.7790	0.6362	0.9290	0.7106
Italy	0.6204	0.4089	0.6299	0.5245	0.8636	0.9018	0.9127	0.5570	0.7990	0.9145	0.9817	0.8909
Luxembourg	0.5733	0.4527	0.5939	0.3973	0.9559	0.9687	0.9853	0.7752	0.8214	0.9419	0.9923	0.7066
Netherlands	0.5726	0.3680	0.4451	0.4812	0.8404	0.8787	0.8772	0.5369	0.9126	0.9071	0.9716	0.9589
Portugal	0.5622	0.3502	0.5267	0.4539	0.9448	0.9693	0.8986	0.7104	0.7330	0.9754	0.9858	0.8032
Spain	0.7331	0.6056	0.6497	0.6283	0.9271	0.9587	0.9566	0.7746	0.9261	0.8991	0.9405	0.8551
Sweden	0.8815	0.5789	0.8172	0.7639	0.9108	0.8543	0.9100	0.5776	0.8646	0.8530	0.9293	0.7330
Switzerland	0.5968	0.5005	0.5056	0.5572	0.7985	0.8532	0.8549	0.6982	0.9089	0.9605	0.9783	0.9359
U.K.	0.6640	0.5194	0.6479	0.5684	0.7800	0.7853	0.8995	0.5017	0.7792	0.7352	0.8694	0.7780
Total	0.6487	0.4719	0.5765	0.5321	0.8066	0.8586	0.8970	0.6400	0.8447	0.8623	0.9364	0.8308

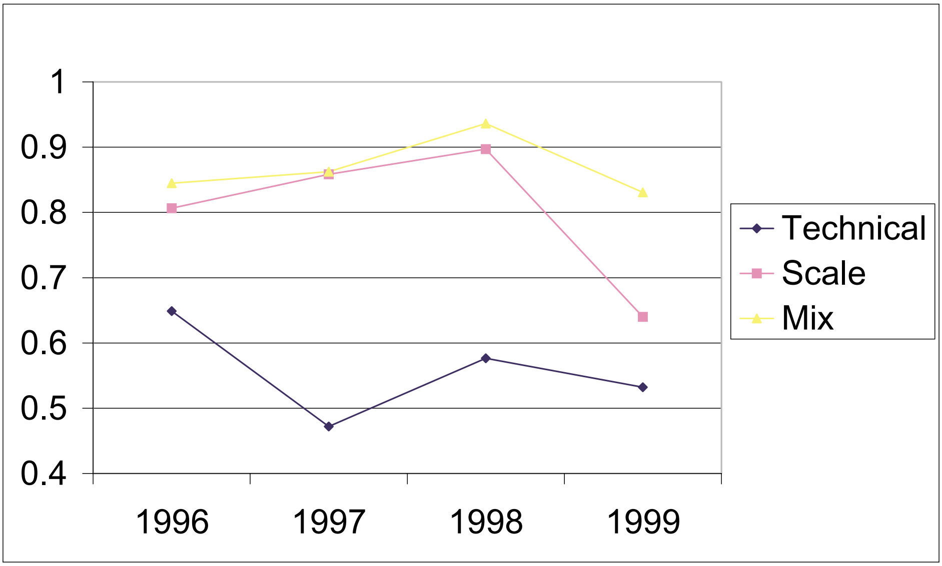

Figure 2: Average efficiency scores (all countries)

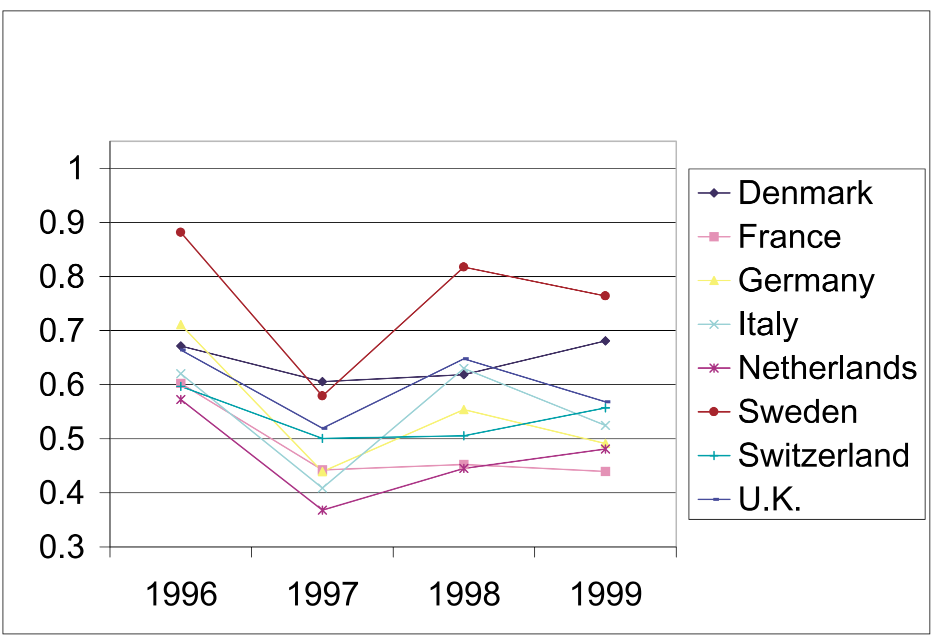

Figure 3: Average technical efficiency

Table 4:
Average projections to efficiency frontier by country, 1996–1999. Insurance companies transacting long-term business
Average projected values as % average original values

	Expenses	Capital	Reserves	Creditors	General NEP	Long-term NEP	Invest Inc
1999							
Austria	57.5	53.8	45.4	57.7	100.7	105.3	100.0
Belgium	79.5	46.1	73.3	60.3	100.0	103.6	105.2
Denmark	65.4	76.8	75.3	70.8	100.1	221.3	100.0
France	81.8	75.6	76.4	83.5	100.6	102.6	111.6
Germany	71.4	83.1	65.7	57.6	100.4	103.1	109.5
Greece	63.3	69.9	74.3	44.6	138.0	163.9	100.0
Ireland	39.0	28.7	38.4	42.8	119.1	131.6	100.0
Italy	86.5	72.1	85.1	84.0	100.7	100.3	101.6
Luxembourg	22.3	1.8	9.6	7.4	110.6	106.2	123.8
Netherlands	77.1	65.1	75.7	53.8	116.1	100.7	100.0
Portugal	55.4	47.0	53.2	35.0	100.0	101.5	126.9
Spain	82.2	80.5	66.4	47.8	100.7	110.1	123.0
Sweden	86.6	91.1	90.5	64.1	125.4	108.1	101.7
Switzerland	86.7	79.4	83.1	88.0	100.1	100.1	119.2
U.K.	85.7	80.0	86.6	82.9	104.6	108.3	100.2
1998							
Austria	50.1	48.2	46.4	48.4	100.2	111.9	100.0
Belgium	57.8	48.4	59.0	54.2	100.2	119.9	100.5
Denmark	56.4	51.2	59.5	47.5	100.4	112.4	100.0
France	80.2	85.1	84.2	95.3	100.8	101.1	101.1
Germany	70.8	70.8	57.6	41.8	100.5	103.1	100.0
Greece	40.4	43.1	37.9	17.7	100.0	110.1	100.0
Ireland	69.2	74.4	72.2	64.9	164.6	100.0	100.2
Italy	87.2	76.4	80.2	81.4	100.3	102.7	100.1

continued overleaf

Table 4:
(continued)

	Expenses	Capital	Reserves	Creditors	General NEP	Long-term NEP	Invest Inc
Luxembourg	61.0	48.4	61.6	27.0	101.3	100.0	100.0
Netherlands	60.9	36.8	50.4	27.2	101.4	100.0	102.3
Portugal	86.6	81.3	96.3	73.8	100.2	100.4	100.0
Spain	72.9	70.2	64.9	58.4	100.3	103.2	100.7
Sweden	83.5	93.2	90.3	46.5	112.0	104.9	100.0
Switzerland	87.9	81.1	78.2	85.4	100.0	100.3	100.0
U.K.	87.1	87.9	90.1	79.2	103.0	113.2	100.1
1997							
Austria	62.1	59.3	52.8	63.6	100.0	105.6	100.0
Belgium	53.9	53.5	52.5	25.2	100.0	124.6	100.2
Denmark	63.4	66.6	73.3	62.8	100.1	169.3	100.0
France	87.4	76.2	74.6	83.7	100.1	100.9	100.3
Germany	77.2	82.7	73.6	57.3	100.1	101.9	101.0
Greece	37.9	39.3	34.2	36.5	100.0	217.1	100.0
Ireland	67.3	77.8	78.5	65.7	100.0	268.4	100.0
Italy	81.2	73.3	76.9	77.2	100.3	109.3	101.2
Luxembourg	55.0	41.8	42.6	19.2	100.0	105.5	100.0
Netherlands	59.7	44.2	56.7	31.1	102.0	110.6	100.0
Portugal	41.3	36.9	39.0	19.5	100.0	116.7	100.1
Spain	74.9	71.3	55.1	69.8	100.0	104.5	104.9
Sweden	85.4	80.2	84.0	38.2	101.7	105.4	100.0
Switzerland	71.0	71.8	79.0	64.1	102.6	100.1	114.0
U.K.	83.1	88.9	88.0	73.6	102.4	126.5	100.0
1996							
Austria	68.7	67.2	64.1	67.2	100.0	112.7	100.0
Belgium	57.2	58.0	58.6	22.1	100.0	118.2	101.0
Denmark	77.3	82.1	87.0	72.9	100.5	140.1	100.0

France	80.2	76.3	82.3	38.1	100.7	100.6	102.9
Germany	85.3	92.8	91.4	77.5	100.8	101.1	100.1
Greece	40.2	52.4	44.5	34.4	100.0	285.3	100.0
Ireland	71.0	73.5	74.1	63.4	100.6	119.0	100.0
Italy	88.2	82.5	89.1	87.6	100.0	109.3	100.0
Luxembourg	69.0	50.2	62.5	28.4	101.1	136.6	100.0
Netherlands	65.8	64.5	64.6	22.9	102.8	105.1	100.0
Portugal	58.0	52.8	56.6	20.8	100.2	143.1	100.0
Spain	78.3	80.4	79.0	72.2	100.1	106.6	101.1
Sweden	91.2	93.6	95.6	85.9	102.6	112.2	100.0
Switzerland	68.5	77.2	77.6	61.7	102.7	101.2	114.9
U.K.	80.4	82.9	85.7	76.2	103.2	107.3	100.2

account of both the pure technical efficiency and mix efficiency scores as described in Cooper *et al.* (2000, ch. 4). The table shows projected values as a percentage of original values for the four inputs and three output variables. The lower (higher) the input (output) percentage the greater the source of inefficiency on average. Thus, the figure under the "expenses" column of 85.7 for 1999 shows that U.K. long-term insurers are required, on average, to reduce total operating expenses by 14.3 per cent relative to the European frontier; whereas the figure of 106.2 for "long-term" NEP indicates a suggested expansion of long-term premiums by 6.2 per cent.

The projection percentages of Table 4 enable an international comparison of the source of inefficiency among long-term insurers. It is clear that the pattern has changed over time. However, the following box cites those countries whose insurers, on average, were particularly inefficient in the utilization of inputs or the production of outputs in most of the years under investigation. Greece and Luxembourg have been omitted from the box on account of the small number of insurers in the analysis.

Source of inefficiency	**Country**
Excessive operating expenses	Austria, Belgium, Netherlands, Portugal
Over-capitalized	Austria, Belgium, Netherlands, Portugal
Excessive technical reserves (i.e. poor claims experience)	Austria, Belgium, Netherlands, Portugal
Over-borrowing	Belgium, Germany, Netherlands, Portugal, Sweden
GNEP too low	—
LTNEP too low	Belgium, Denmark, Ireland
Insufficient investment income	France, Spain, Switzerland

5. An analysis of inter-company efficiency differences

An exploration of inter-company differences in efficiency necessitates a two-stage analysis whereby efficiency scores from the first-stage DEA process are regressed against environmental variables. By definition, these environmental variables are not decision variables that would otherwise figure in the firm's choice of the nature or level of inputs and/or outputs (as these should have already been included in the DEA analysis). Second-stage regressions commonly utilize a Tobit model for censored data (rather than ordinary least squares) in order to allow for the restricted (0,1] range of Farrell efficiency scores. A list of selected variables and descriptive statistics is provided in Table 5.

Many two-stage studies of company efficiency choose company size as a key environmental variable on the basis that management cannot easily use size as a decision variable. Since the Pearson correlation coefficient between inputs, outputs and total assets is extremely high (ranging from 0.535 to 0.925), it is preferable to use the natural logarithm of total assets in $ million (SIZE) as a measure of company size, and this reduces the correlation with inputs and outputs to between 0.156 and 0.558. The variable $SIZE^2$ is also included in order to pick up any non-linear relationship between size and efficiency. Many of the other environmental variables are included to pick up differences between companies in terms of risk (e.g. the gearing ratio GEAR, liquidity LIQUID, total profitability PROFIT, reliance on reinsurance REINS, and solvency SOLV).

Table 5:
Explanatory environmental variables for Tobit regression on efficiency scores and projections, N = 2319, 1996–1999

Variable	Description	Mean	Stand. Dev.	Min.	Max.
GEAR	Gearing ratio = borrowing from creditors as a % of capital	168.40	558.60	0.00	8940.69
LIQUID	Cash + deposits with credit institutions as a % of total assets	4.42	8.30	−0.52	83.32
MUTUAL	1 if company has zero share capital; 0 else	0.17	0.37	0	1
PROFIT	Profit or loss on non-technical account as a % of total net earned premiums	10.26	54.58	−361.39	1618.52
REINS	Reinsurance premiums ceded (net of rebates and refunds) as a % of total GWP	7.48	12.61	−157.70	119.23
SIZE	Natural logarithm of assets ($m)	7.46	2.00	0.32	13.14
SOLV	Capital as a % of total assets	12.13	12.95	0.08	91.79

The results of the Tobit regression on the technical, scale and mix efficiency scores are presented in Table 6. The sample includes all European insurance companies transacting long-term insurance business in a pooled dataset covering the years 1996–1999. Country and year dummy variables are included to pick up any country and time effects respectively. The main results are as follows:

(1) Technical and scale efficiency scores are strongly associated with insurer size, with clear evidence of a U-shaped relationship for the former (i.e. both small and large insurers appear to have higher technical efficiency) and an inverted-U for the latter (i.e. both small and large insurers appear to have lower scale efficiency). On the other hand, mix efficiency seems to increase linearly with size: larger insurers seem to have improved flexibility to arrange the best combination of inputs and outputs. Thus insurers of all sizes have the potential to score well in efficiency terms: large companies should be able to demonstrate technical and mix efficiency but suffer in scale terms; small insurers should gain advantages from technical efficiency but not scale or mix; and middle-sized insurers can benefit from scale efficiency and some possible mix efficiency too;

(2) MUTUAL companies have a higher average level of technical efficiency than stock insurers, but a lower level of mix efficiency – perhaps reflecting a lack of flexibility in the arrangement of inputs and/or outputs;

(3) An increase in the solvency ratio (SOLV) is associated with higher technical efficiency; thus customers seem to "reward" highly solvent insurers with more premium income. The relationship is reversed when scale efficiency is considered;

(4) There seems to be little relationship between liquidity and efficiency, and profitability

Table 6:
Results of Tobit regression on efficiency scores. Pooled data 1996–1999, N = 2319

	Technical		**Scale**		**Mix**	
	Coeff.	**Signif.**	**Coeff.**	**Signif.**	**Coeff.**	**Signif.**
Constant	1.01540	0.00000	0.09434	0.00450	0.59343	0.00000
GEAR	0.00001	0.41860	0.00002	0.00460	−0.00003	0.00110
LIQUID	−0.00043	0.55890	0.00034	0.40340	0.00005	0.94320
MUTUAL	0.03383	0.03600	0.01471	0.15870	−0.02057	0.08570
PROFIT	0.00016	0.22840	0.00024	0.00000	−0.00035	0.00000
REINS	−0.00057	0.15880	0.00029	0.31990	−0.00192	0.00000
SIZE	−0.18497	0.00000	0.25132	0.00000	0.03858	0.00470
SIZESQ	0.01714	0.00000	−0.02003	0.00000	−0.00044	0.59410
SOLV	0.00310	0.00000	−0.00064	0.03900	0.00026	0.52050
AUSTRIA	0.00604	0.89120	0.08926	0.05410	0.22835	0.00000
BELGIUM	−0.00766	0.75580	0.06475	0.00470	0.09865	0.00000
DENMARK	0.11172	0.00020	0.06006	0.01720	0.05899	0.00310
FRANCE	−0.11071	0.00000	0.02885	0.02850	0.08386	0.00000
GERMANY	−0.03040	0.10630	−0.01745	0.11250	0.10646	0.00000
GREECE	0.01189	0.90490	−0.00325	0.95480	0.06080	0.52510
IRELAND	0.04743	0.36940	−0.00936	0.78040	−0.00469	0.86690
ITALY	0.02804	0.23150	0.00812	0.61430	0.11872	0.00000
LUXEMBOURG	0.07266	0.10190	0.05093	0.46280	0.12657	0.00440
NETHERLANDS	−0.17589	0.00000	0.05124	0.02610	0.09085	0.00000
PORTUGAL	−0.01300	0.74680	0.04734	0.09800	0.13262	0.00000
SPAIN	0.18437	0.00000	0.06027	0.00710	0.15150	0.00000
SWEDEN	0.13959	0.00000	0.07475	0.00020	0.09913	0.00000
SWISS	−0.07189	0.00850	0.05819	0.01620	0.12157	0.00000
YEAR1997	−0.18575	0.00000	0.05164	0.00000	−0.03193	0.00670
YEAR1998	−0.10754	0.00000	0.10684	0.00000	0.04876	0.00010
YEAR1999	−0.17309	0.00000	−0.13521	0.00000	−0.07467	0.00000
Heteroscedasticity						
SIZE	−0.02517	0.00510	−0.00334	0.46090	−0.10792	0.00000
Disturbance Std Dev						
Sigma	0.30325	0.00000	0.17696	0.00000	0.43386	0.00000
Adjusted R^2	0.33381		0.51894		0.18528	

has a significantly positive influence on scale but a negative impact on mix. A high proportion of reinsurance is also associated with lower mix efficiency;

(5) The country dummies confirm the international differences in average efficiency that were identified earlier: Danish, Spanish and Swedish insurers seem to have the highest levels of technical efficiency.

Residuals from the Tobit model of efficiency scores represent company efficiency after

Table 7:
The best performing European long-term insurers, 1999 (based on residual Tobit scores)

Technical efficiency	
Gerling Globale Ruck. (Swiss)	CIGNA Life Ins Co of Europe (Belgium)
DBV-Winterthur Ruck. (Germany)	Merkur Wechselseitige (Austria)
Veritas Lebensversicherung (Germany)	Previposte (France)
Fidelity Investments Life (U.K.)	Merchant Investors (U.K.)
Strasbourgeoise Soc. d'Assurance (France)	Baillie Gifford Life (U.K.)
Professional Life Assurance (U.K.)	Wurttembergische Gemeinde (Germany)
Unive Verzekeringen (Netherlands)	Quelle Krankenversicherung (Germany)
Contassur SA (Belgium)	MACIF (France)
NEUe Ruck. (Swiss)	Assiba Societa di Assicurazioni (Italy)
NV Secura Belgium Re (Belgium)	SCOR (France)
Scale efficiency	
HDI Konzern (Germany)	LVM Konzern (Germany)
Teachers Assurance (U.K.)	AMF Pension (Sweden)
BVV Versicherungsverein (Germany)	Medi Assurance Vie Professions (France)
MACIF (France)	AXA Colonia Konzern (Germany)
Livforsakring AB SEB Trygg Liv (Sweden)	Mannheimer Versicherungen (Germany)
AXA Royale Belge (Belgium)	Mercury Life Assurance (U.K.)
Sparkassen-Versicherung (Germany)	Lloyd Adriatico SpA (Italy)
Assicurazioni Generali SpA (Italy)	Stuttgarter Versicherungsgruppe (Germany)
Liberty International Pensions (U.K.)	Groupe Medi-Assurances (France)
Les Mutuelles du Mans Assurances (France)	Bayerische Beamten (Germany)

continued overleaf

Table 7:
(continued)

Mix efficiency	
Volksfursorge Kranken (Germany)	Livforsakring AB SEB Trygg Liv (Sweden)
Pensionskassen for jordemodre (Denmark)	Hanse Regional Kranken (Germany)
Eurolife Assurance Company (U.K.)	AMF Pension (Sweden)
Professional Life Assurance Company (U.K.)	Pensionskassen Ergoterapeuter FysioterapEuter (Denmark)
Previposte (France)	Magistrenes Pensionskasse (Denmark)
Dentists Provident Society (U.K.)	Hamilton Life Assurance (U.K.)
Holmia Livforsakring (Sweden)	Hiscox Insurance Company (U.K.)
Fidelity Investments Life Insurance (U.K.)	Baillie Gifford Life (U.K.)
SkandiaLink (Denmark)	DBV-Winterthur Ruck. (Germany)
Quelle Krankenversicherung (Germany)	Strasbourgeoise Soc d'Assurance (France)

the effects of the environmental variables such as size, structure, and country of licence have been removed, and perhaps provide the best indication of the inherent ability of company management to turn inputs into outputs. Those companies with the most advantageous residual efficiency scores are provided in Table 7.

A cursory examination of the insurers listed in Table 7 suggests that the most efficient insurers (after adjusting the impact of size, solvency, mutuality and country effects) are the ones that focus on specialist market sectors. The most efficient U.K. insurers seem to be ones which are linked to merchant banks or investment houses (such as Fidelity or Baillie Gifford) or which specialize in group pensions business. A number of the most efficient German insurers appear to be specialist reassurance companies.

6. Discussion and conclusions

This paper explores the efficiency of European specialist and composite insurers transacting long-term insurance business. The concept of efficiency concerns an insurer's ability to produce a given set of outputs (such as premiums and investment income) via the use of inputs such as administrative and sales staff and financial capital. The study uses value measures of insurance company inputs and outputs to undertake an exploration of the technical efficiency of European insurers. This is achieved by benchmarking the relative performance of insurers licensed to transact long-term business in 15 European countries using data from Standard & Poor's *Eurothesys* database for the years 1996–1999.

Data Envelopment Analysis is utilized to generate three different efficiency measures for each long-term insurer (namely pure technical efficiency, scale efficiency, and mix efficiency). It is clear from the analysis that there are wide variations in all types of efficiency. The most efficient insurers in pure technical terms are likely to be either very large or very small (specialist) insurers. Mutuality and financial security are also conducive to technical efficiency. A different picture emerges when we turn to scale and mix efficiency.

A comparison of average efficiency among 15 European countries shows some striking international differences. Insurers transacting long-term business in the U.K., Spain, Sweden and Denmark are likely to have highest average levels of technical efficiency. On the other hand, U.K. insurers appear to have particularly low levels of scale and mix efficiency when compared to their European counterparts. The source of these international differences is not readily apparent.

An interesting picture emerges when efficiency levels are compared over time. There seems to be some evidence that average technical efficiency declined over the four years of analysis. It may be a coincidence, but this was also a period of radical restructuring in many European markets. Since a rationalization process of mergers and acquisitions uses up resources (for no immediate short-term gain in outputs) an adverse impact on efficiency is perhaps inevitable.

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