

Insurance Efficiency in the Nordic Countries

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This article provides evidence of the relative competitiveness of the property-liability insurance industries in the Nordic countries in the recent years. The nonparametric Data Envelopment Analysis (DEA) methodology has been used for calculating the efficiency of the Nordic insurance companies relative to the national and the pooled data sets. The article also computes productivity gains in the insurance sector using Malmquist indices. The conclusion is that the national Nordic insurance markets differ far more widely in terms of structure and development than it is typically believed.

Introduction

The economic integration within the European Union and the European Economic Area has opened up for more intense competition on the European insurance markets, which may potentially result in a substantial structural change within the insurance industry. Insurers chartered in one country are allowed to set up branches in any other country, subject to the regulations of their home country. Political authorities in most countries consider the insurance industry a key and are likely to take a strong interest in the development of this industry. Thus, the competitiveness of the national insurance industries will be an issue of great concern.

This article considers the relative efficiency

of the insurance industries in Denmark (D), Finland (F), Norway (N) and Sweden (S) as observed in the five years from 1993 to 1997. These four Nordic neighbouring countries are part of the European Economic Area, and they constitute a region where cultural barriers to entry into one of the other three countries are minimal. Differences in average insurance productivity between the four countries will be considered together with the spread of efficiency levels within each country.

The basic methodological approach is to formulate a best practice production frontier for the insurance industries in each country as well as a Nordic frontier based on the pooled cross section data¹. The production frontier

will be specified as piecewise linear in the three outputs and one input for which comparable data has been collected. The structures of the Nordic insurance sector are examined by studying the efficiency of the individual insurers. Using Data Envelopment Analysis (DEA) as the way of establishing the frontier, it is considered whether individual insurance companies are efficient by comparing them to the best practice frontier determined by the observation set². Malmquist indices (Berg *et al.* 1992) will be used to characterize the productivity differences between insurance companies in different countries. This allows for a decomposition of the productivity differences into one term representing the insurance companies' productivity levels relative to their respective national best practice frontiers, and one term representing the difference between the national frontiers.

The DEA method is briefly introduced in section 2, where the Malmquist index is defined, too. The data are presented and the specifications of inputs and outputs are described in section 3. Section 4 presents the

empirical results, and finally some concluding remarks are provided in section 5.

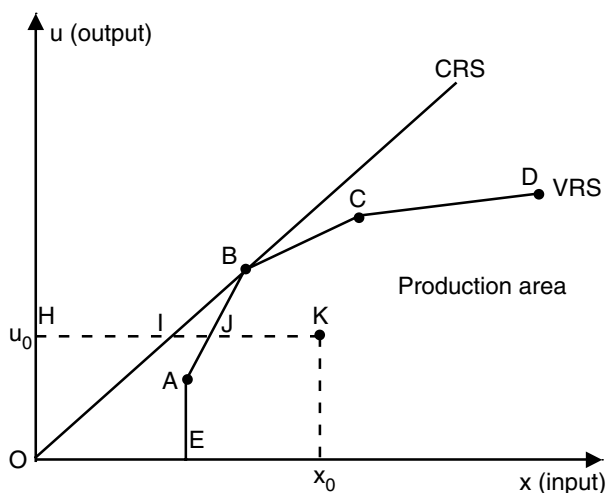
2. Methodology

The DEA approach is an analytic method that creates an efficient frontier by placing focus on deviating observations in a population and calculating these observations distance to the other observations. The method originally formulated by Charnes *et al.* (1978) and applying Farrells (1957) measures is typically used to identify the most efficient units and to evaluate the distribution of inefficiency in a population.

In this section the theoretical base of the method is described while details of the calculations are left out³.

In figure 1 the efficient frontier is illustrated in a simple case where an insurance company is assumed only to be represented by one production factor (input) and one product (output). The efficient frontier is shown under two alternative assumptions about scale properties. It is assumed that the observed combinations of input and output for the units are represented by A, B, C, D and K. Under the assumption of variable return to scale (VRS) the efficient frontier is EABCD and under the assumption of constant return to scale (CRS) the efficient frontier is the straight line through origo and B.

Figure 1: Illustration of the efficient frontier and efficiency-measurements under the assumption of constant return to scale (CRS) and variable return to scale (VRS).



For unit K, the input is x_0 and the output is u_0 . The CRS frontier is a straight line from the origin through point B. The VRS frontier is a piecewise linear line connecting points E, A, B, C, and D. The area between the CRS line and the VRS line is labeled 'Production area'.

Let it be assumed that unit K is producing u_0 of output by use of x_0 of input. Then two different measurements for efficiency can be calculated, corresponding to the two different assumptions on scale properties, CRS and VRS (i.e. Banker, Charnes and Cooper, 1984; Färe *et al.* 1985, 1994). These measure-

ments are in the DEA-literature denoted as Farrell technical efficiency under CRS respectively VRS. The input oriented Farrell technical efficiency under CRS for the unit, that is operating with the input-output combination of (u_0, x_0) , is measured as HI/HK and the input oriented technical efficiency under VRS as HJ/HK .

The description of the non-parametric frontier as an envelopment of production area as well as the geometric interpretation of efficiency measurements can without problems be generalised to more dimensions. In addition there can also be calculated an output oriented efficiency by keeping the input fixed at x_0 and comparing the observations (u_0, x_0) with a point vertically above on the non-parametric frontier.

The use of DEA implies use of linear programming to construct the piecewise linear production function, i.e. the non-parametric frontier which represents the areas of production, denoted by EABCD in the VRS-case in figure 1. Beside the individual insurance companies efficiency can be calculated by the use of linear programming as the distance to the non-parametric frontier.

In order to identify productivity differences between two insurance companies the Malmquist productivity index is used (see Malmquist, 1953, and Caves *et al.* 1982a and 1982b). The productivity index is based on binary comparisons between two different production units, denoted 1 and 2 for short. Only quantities are involved, and at least one technology has to be known. As a convention unit 2 will be compared with unit 1.

The idea of what Caves *et al.* (1982b) termed the Malmquist unit 1 input based productivity index is to find the minimal proportional scaling of inputs for unit 2, so that its scaled input vector and its observed output vector are just on the production surface of unit 1. In order to obtain circularity of the index the original Caves *et al.* (1982a)

index was generalised in Berg *et al.* (1992). Although the index is used in a cross section setting and thus do not need chainability as such, the chain version was preferred⁴.

It can now be found which proportional adjustment of the observed input vector of the country no. 2 unit is required for the unit to be on the frontier function of the reference country i with observed outputs, and which proportional adjustment of the observed input vector of the country no. 1 unit for observed outputs is necessary for the unit to be on the same country i frontier function. Both measures may be larger than one. If $M_i > 1$, then the country no. 2 unit is more productive than the country no. 1 unit. Productivity comparisons are traditionally performed by calculating total factor productivity, i.e. comparing an aggregate of outputs to an aggregate of inputs. Using the ratio of efficiency scores means that the relative distance from the same frontier in the input dimension is used as an indicator of productivity. The productivity difference due to different scale properties at the two points on the frontier function is also captured.

In the presence of inefficient observations, differences in productivity are the net effect of differences in efficiency relative to national frontiers and in the national frontier production functions. So Malmquist productivity index $M_i(1,2)$, can be multiplicatively decomposed into two parts showing the catching up (efficiency change) $EC(1,2)$ and the pure technology shift $TC_i(1,2)$.

The frontier technology change is a relative change between country i technology and country 2 technology on the one hand, and country i technology and country 1 technology on the other hand. The measure of distance between technology 1 and 2 is based on the observation of unit 2, and the measure of distance between technology 1 and 1 is based on the observation of unit 1. The frontier change term measures the distance between

technologies 2 and 1, but it is a distance measured relative to the common reference technology i . When calculating the efficiency scores in the Malmquist index, the subscript i points to the observations belonging to that definition of the production set. Observations 1 and 2 need not belong to the set spanning the frontier. A general problem is that these scores may not exist in the VRS case. The Standard solution is to impose CRS when calculating the Malmquist indices, because then it is known that it is possible to relate all observations to the frontier technology, i^5 .

3. The Data

The unit of analysis of this study is the individual property liability company under the control of the Swedish, Danish, Norwegian and Finnish supervision agencies (home country supervision, cf. the third generation directive). This unit has been created by leaving out the areas of life assurance, foreign property liability insurance business and reinsurance. Where two or more property liability insurance companies have shared ownership the results stated apply to the "holding company". In the same way, the smallest companies with a total market share of less than 5 percent of their respective home markets have been aggregated into one holding company. Lastly, specialized companies with a limited range of products have been merged into a "single business company". This is the reason why the data set is composed of observations from 46 Nordic insurance companies from 1993 up to and including 1997. Out of these 46 Nordic insurance companies 18 are Danish, 10 Finnish, 8 Norwegian and 10 are Swedish.

The EU directive (91/674) regarding the annual accounts and consolidated accounts of insurance companies provides for a harmonization of the basic regulations about the presentation of insurance companies annual statements of account. With a view to establishing

a joint Nordic platform, it has been necessary to make some degree of adjustment of the Swedish, Norwegian and Finnish data to Danish accounting principles. This adjustment serves to ensure that comparisons can be made between companies in each of these countries and across the countries and throughout the survey period. The adjustment has been made with the assistance of the supervision agencies and the insurance associations in each of the countries concerned.

The need for comparable data from different countries and over time imposes strong restrictions on the variables that can be used. In this report it has been chosen to represent insurance output by a vector consisting of three variables, namely "premium income from commercial insurance" (u_1), "premium income from personal accident insurance" (u_2) and "premium income from private insurance and motor vehicle insurance" (u_3). For the production of outputs, the insurers are assumed to utilize the input "total net operating expenses and gross claims paid" (x). To convert values in local currencies into a common currency, the official annual average of exchange rates reported by the Danish Central Bank have been used.

4. Empirical results

Insurance companies activities are subjected to a framework of rules and regulations set up by the surrounding world, primarily through government legislation, directives and regulations by national supervision agencies and antitrust commissions and general financial policies. Add to this the pressure exerted by society as represented by the stock exchange, the press, employee unions, customers and creditors and you have a specific national framework within which the property liability business will have to be conducted.

Within the limits thus imposed on the property liability insurance business, the individ-

Table 1. Direct Nordic non-life insurance 1997.

Danish Insurance 1997

Million DKK with adjustment of reserves	Stock Gross Premium	%	Mutual Gross Premium	%	Foreign Gross Premium	%	Total Gross Premium	%
Non-life Insurance								
Commercial	7.534	36,3	1.932	31,2	205	57,5	9.671	35,5
Private	4.464	21,5	1.299	21,0	38	10,6	5.801	21,3
Personal accident	2.374	11,4	1.525	24,7	38	10,6	3.937	14,3
Motor vehicle	6.382	30,8	1.430	23,1	76	21,3	7.888	28,9
Direct Danish Non-life insurance	21.754	73 comp.	6.186	83 comp.	357	5 comp.	27.297	161 comp.

Finish Insurance 1997

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Norwegian Insurance 1997

Million DKK with adjustment of reserves	Stock Gross Premium	%	Mutual Gross Premium	%	Foreign Gross Premium	%	Total Gross Premium	%
Non-life Insurance								
Commercial	7.075	48,3	4.615	56,6	0	0,0	11.690	51,3
Private	2.610	17,8	935	11,5	0	0,0	3.545	15,5
Personal accident	396	2,7	233	2,9	0	0,0	629	2,8
Motor vehicle	4.561	31,2	2.360	29,0	0	0,0	6.921	30,4
Direct Norwegian Non-life insurance	14.642	25 comp.	8.143	27 comp.	0	0 comp.	22.785	52 comp.

Swedish Insurance 1997

Million DKK with adjustment of reserves	Stock Gross Premium	%	Mutual Gross Premium	%	Foreign Gross Premium	%	Total Gross Premium	%
Non-life Insurance								
Commercial	7.075	48,3	4.615	56,6	0	0,0	11.690	51,3
Private	2.610	17,8	935	11,5	0	0,0	3.545	15,5
Personal accident	396	2,7	233	2,9	0	0,0	629	2,8
Motor vehicle	4.561	31,2	2.360	29,0	0	0,0	6.921	30,4
Direct Norwegian Non-life insurance	14.642	25 comp.	8.143	27 comp.	0	0 comp.	22.785	52 comp.

ual company is left with a certain latitude for initiatives. It is the most important task of the board and the management to utilize these possibilities to create an efficient company and to create a competitive position in relation to its competitors. If a company in one country wishes to measure itself against a foreign competitor, it is important to remember that any differences in efficiency scores are due to a combination of a country effect and a company effect.

The efficiency for each of the insurance companies relative to its own national frontier ($i \in \{D, F, N, S\}$) and relative to the pooled technology ($i=k$) has been calculated. A common technology base facilitates comparisons across countries, but it should be noted that the choice of base will influence the results. In this report the pooled Nordic data set has been chosen to define the reference technology but any country could also have been used (cf. Malmquist 1953).

4.1 Static individual country results

The static results show that the individual countries shared a high efficiency score on the national level, both under the CRS-assumption and under the VRS-assumption. However there is a difference in the standard deviation, which when compared with the results at the company level, indicates structural differences in the individual countries.

The Danish property liability market is characterized by a large number of companies with highly different efficiency scores while the Finnish market is more homogeneous with efficiency scores being independent of company size; both the small and the large companies are efficient.

The Norwegian insurance market is very polarized with the three largest insurance companies having more than a 70 percent market share and the remaining business insurance market being dominated by small

company-owned captives. The Swedish market is dominated by five major property liability companies in addition to a large number of considerably smaller companies. There is no significant number of middle sized companies, but all companies that attempt to conduct nation-wide business within all lines of insurance have efficiency problems.

There are no demonstrable advantages of scale in the Nordic property liability insurance market, but in the strongly polarized Norwegian market the disadvantages of scale are seen at a higher volume than in the other Nordic countries. In all Nordic countries the product mix seems to be more important than size.

Correspondingly the results show differences between business insurance and private insurance markets, i.e. individual risks vs. mass risks, both with regard to distribution and to the onset of disadvantages of scale. The advantages of scale are largest with mass risk.

All countries show saving potentials ranging in 1997 from DKK 3,8 billion in Denmark to DKK 1,0 billion in Finland under the CRS-assumption. Relatively the savings potentials are also largest in Denmark and smallest in Sweden. Under the VRS assumption the savings potential is largest in Denmark and smallest in Finland both in real terms and relatively.

In all countries mergers of companies not larger than DKK 200 million would lead to advantages of scale while no advantages would be obtained from mergers of major companies.

4.2 Dynamic individual country results

A dynamic perspective of the years 1993-1997 applied on each of the four countries shows rather a significant growth in efficiency for three of the four countries. During the years 1993-1997 Denmark saw an increase in average efficiency levels from 0,87 to 0,92. This increase happened against a background

Table 2: Efficiency-results based on individual country data (1997).

Country	Efficiency				Savingspotential			
	CRS		VRS		CRS		VRS	
	Eff.	St.dev.	Eff.	St.dev.	Savings	%	Savings	%
D	0,92	0,14	0,96	0,13	3,8 bill.	12,5 %	2,2 bill.	7,2 %
F	0,93	0,07	0,98	0,04	1,0 bill.	6,3 %	0,1 bill.	0,8 %
N	0,93	0,12	0,97	0,09	1,7 bill.	7,3 %	0,3 bill.	1,2 %
S	0,91	0,12	0,98	0,06	1,5 bill.	4,3 %	0,4 bill.	1,1 %

of technological setback and an even more significant development in efficiency, which means that the savings potential was even more pronounced at the beginning of the period that the actual results calculated at the end of the period.

This development is due to the completion of the mergers that followed in the wake of the financial collapses of the insurance companies "Baltica" and "Hafnia" in 1992 and due also to a costly fight about market shares initiated by the companies that did not participate in the mergers at a time which they could expect to be convenient with the two largest players in the market being preoccupied with completion of the mergers.

In the Finnish property liability insurance market the financial collapse of the early 1990's led to a concentration of a few major companies with sufficient financial strength to weather the storm of crisis. Because of this two opposite trends were seen in the finish insurance market in the years 1993-1997 with

the largest multi-business companies experiencing an increase in efficiency during this period while the majority of the medium-seized companies experienced a fall in productivity during this five-year period.

Therefore the average development in efficiency becomes less significant. The diachronic development may however be seen as an indicator that competition between the Finnish insurance companies exist and may even have become more keen during the period 1993-1997 and that the insurance market is not particularly segmented.

In the Norwegian insurance market the increase in productivity amounted to approximately 2 percent. Average efficiency is high and stable during this period and is the reason for the positive development despite a minor technological setback.

Part of this development is company specific but it is also due to the fact that the deregulation of the Norwegian insurance market did not take place until the end of this

Table 3: Malmquist indices based on individual country data.

	CRS-M					CRS-EC					CRS-TC				
	93-97	93-94	94-95	95-96	96-97	93-97	93-94	94-95	95-96	96-97	93-97	93-94	94-95	95-96	96-97
D	1,03	1,08	0,91	1,03	1,02	1,08	1,06	1,00	1,01	1,01	0,95	1,02	0,91	1,01	1,01
F	1,17	0,90	1,14	1,10	1,00	1,30	1,12	1,02	0,95	1,16	0,90	0,81	1,12	1,15	0,88
N	1,02	1,15	0,92	0,97	1,03	1,04	1,04	0,97	1,00	1,04	0,99	1,10	0,94	0,96	0,99
S	0,86	0,97	1,05	0,78	1,17	0,96	1,05	0,94	0,99	1,05	0,89	0,92	1,13	0,78	1,08

period. The Norwegian property liability market saw the strongest concentration within Nordic insurance with the three major insurance companies having market shares in 1997 of 32, 23 and 18 percent respectively. The trend towards concentration was increasing during the period in question.

Only the Swedish property liability market experienced a serious drop in productivity during the period 1993-1997. A contributory cause of this recorded drop is the onset of negative trend regarding technology as measured in terms of cost consumption during the period in question.

During this five-year period there was considerable variation in efficiency development from one company to another with the most serious setback being suffered by the property liability companies that already had the lowest efficiency while the companies that already enjoyed a favorable position in this respect were able to hold on to that position. This development allows the interpretation that the adaptation to the structural changes has not been fully implemented yet in Sweden.

The dynamic study does in fact demonstrate the difficulties that foreign companies have in gaining a foothold in other national markets, e.g. the companies "Trekroner" and "Kgl. Brand" in Denmark the "Zürcher protector" in Norway and "Storbrand" in Sweden. The only exception seems to be "Vesta" in Norway, probably due to the extraordinary polarization in this market with the three major companies including "Vesta" having a combined market share of 73 percent of the total market.

4.3 Static pooled Nordic data set

If the Nordic insurance markets are considered as one common insurance market with all companies acting in the same market, a number of interesting conclusions may be drawn. Estimates of the technology component thus show that by its efficiency frontier

the Norwegian property liability industry holds a leading position in the Nordic market followed by Danish, Finnish and lastly Swedish insurance companies.

The total savings potential calculated on the basis of the pooled Nordic data set is larger than when based on national data and it amounts to DKK 19 billion under the CRS-assumption and a little more than DKK 7 billion under the VRS-assumption. In relation to total cost this corresponds to 18 percent and 6 percent respectively.

Also comparisons made between the largest company in each of the countries reveal interesting results as the Malmquist index may be decomposed to allow differentiation between that part of the inefficiency that is due to company specific factors and the part that is due to structural differences in the countries comprised by this study.

Estimates of the company component (EC) show that the Norwegian study finds a higher efficiency level in the Norwegian "Storebrand" than what has been found for the Finnish "Sampo", the Swedish "Länsförsäkring" and the Danish "Tryg-Baltica" in similar national studies. However, the country component shows that efficiency scores are reached on different bases in each of the countries. The highest reference level is found in Norway followed by Denmark, Sweden and Finland.

In total the Norwegian "Storebrand" has the highest efficiency level under the CRS-assumption but now followed by the Danish "Tryg-Baltica", the Finnish "Sampo" and the Swedish "Länsförsäkring". Under the VRS-assumption the company effect is 1 for all companies and consequently the ranking will be equal to the country effect under this assumption, i.e. the ranking will be Norway, Finland, Denmark and Sweden.

The joint Nordic study support earlier theories about lacking economies of scale in connection with mergers of large companies

Table 4: Inter-country productivity comparisons. Average and largest units in each country (the pooled Nordic sample is used as frontier technology).

Country (First country=1, second country=2)	Malmquist Productivity index $M_i(1,2)$		Efficiency component $EC(1,2)$		Technology component $TC_k(1,2)$	
	VRS	CRS	VRS	CRS	VRS	CRS
Finland-Norway:						
Largest unit	1,00	1,20	1,00	1,02	1,00	1,18
Average unit	1,06	1,15	1,01	1,07	1,04	1,08
Finland-Sweden:						
Largest unit	0,90	1,06	1,00	0,99	0,90	1,07
Average unit	0,84	0,79	0,99	0,92	0,85	0,85
Finland-Denmark:						
Largest unit	0,96	1,09	1,00	0,94	0,96	1,16
Average unit	0,92	0,98	0,94	0,97	0,98	1,01
Norway-Sweden:						
Largest unit	0,90	0,88	1,00	0,97	0,90	0,91
Average unit	0,80	0,68	0,98	0,86	0,82	0,79
Norway-Denmark:						
Largest unit	0,96	0,91	1,00	0,92	0,96	0,99
Average unit	0,87	0,85	0,93	0,91	0,94	0,94
Denmark-Sweden:						
Largest unit	0,94	0,98	1,00	1,06	0,94	0,92
Average unit	0,92	0,81	1,06	0,95	0,87	0,85

(i.e. companies with more than DKK 1 billion in gross premium) and advantages to be derived from mergers of small companies, i.e. companies with an annual turnover of less than DKK 200 million. Generally, the largest companies in all four countries are producing decreasing returns to scale. The medium-sized companies at constant returns to scale and the smallest at increasing returns to scale.

This part of the study also indicates that mergers between Swedish insurance companies can be expected to take place at the “high end” while structural rationalization in Denmark and Finland can be expected to take place at the “low end”.

4.4 Dynamic pooled Nordic data set

A dynamic perspective of the Nordic insurance market in its totality covering the period 1993-1997 shows no measurable development in productivity. However, thus global

view covers a number of opposing trends.

Generally the Danish, Finnish and Norwegian companies shared a positive efficiency development while the Swedish companies experienced a drop in efficiency during that period.

This drop can be attributed to the fact that in 1993 the Swedish insurance companies did in fact have a higher efficiency level than the Nordic average but in the following years of that period, the Swedish insurance industry was overtaken by the other Nordic countries, where a number of structural rationalizations followed the financial collapses that happened at the beginning of that period. Therefore the trend is towards new structural changes within the Swedish insurance industry.

The Nordic insurance market is not characterized by a uniform development. Denmark and Norway follow a common pattern in their development close to the Nordic average while Finland and Sweden follow mutually differ-

ent development paths, which are also different from the Nordic average. Each country seems to have its own specific development pattern.

The data set also offers the opportunity to estimate the results of the inter-Nordic mergers that took place until 1997. Their number is relatively limited with the Danish “Codan” being the owner of “Holmia” in Sweden (originally this company was owned by “Hafnia”, which was taken over by “Codan”) and “Skandia” owning the Norwegian “Vesta” and the Danish “Kgl. Brand”, and lastly the Norwegian “Storebrand” doing business in Sweden in its own name.

Establishing an insurance business in another Nordic country has turned out to be difficult when this is done by setting up a new company. Maybe because the national brand name does not have any effect in the neighboring country and probably also because national differences have been shown to act as barriers to entry.

On the other hand, the study shows that it is possible to operate successfully in the insurance market of another Nordic country when this is done by the acquisition of another company. Thus until recently “Skandia” was operating successfully in Norway through the company “Vesta” which already at the time of acquisition by “Skandia” was a major company. Due to the particular structure of the Norwegian insurance market, the company has been able to develop continuously among the major Norwegian companies with a considerable market share.

“Skandia”, on the other hand, has not been able to develop any volume through the Danish “Kgl. Brand”, probably due to the different market structure in Denmark.

The Swedish “Holmia” has not obtained any volume but it is run as an extremely efficient company thanks to a restructuring during this period with the introduction of a certain degree of product specialization.

Cross-boarder activities such as taking out insurance directly from a company in another Nordic country are considered to be very limited in all of the countries.

The data set also provides the possibility to estimate whether an insurance company can operate a discount business under a different brand name. The only example of this is the Swedish company “Skandia”, which has been running a discount business under the name of “Dial” both nationally and in the other Nordic countries.

“Skandia” has been unable to turn this concept into a success. In Sweden this kind of business has led to cannibalism probably because those insured by “Skandia” were particularly aware of that possibility. In Denmark the trend has been negative and this particular business concept is being phased out.

The data set also makes it possible to find out whether any changes in the return to scale situation have taken place during the period covered by the study. The results from the Finnish and the Norwegian insurance markets, which were already very concentrated at the beginning of the period, do not point to

Table 5: Malmquist indices based on pooled Nordic data set.

	CRS-M					CRS-EC					CRS-TC				
	93-97	93-94	94-95	95-96	96-97	93-97	93-94	94-95	95-96	96-97	93-97	93-94	94-95	95-96	96-97
D	1,02	1,09	0,90	1,02	1,03	1,17	1,08	0,97	1,04	1,08	0,88	1,01	0,93	0,98	0,95
F	1,07	0,88	1,11	0,98	1,08	1,19	0,91	1,26	0,93	1,11	0,89	0,97	0,89	1,06	0,98
N	1,02	1,15	0,91	0,98	1,03	1,16	1,05	1,00	1,04	1,09	0,89	1,09	0,92	0,94	0,95
S	0,85	1,01	1,07	0,84	1,07	0,97	0,97	1,15	0,86	1,11	0,87	1,04	0,93	0,97	0,96

any such changes. Nor does an analyses of the less concentrated Swedish property liability market indicate that any major changes in the return to scale situation are underway. Within Danish property liability insurance the level of critical mass seems to have gone up from 1993 to 1997.

A number of small companies with annual sales of no more than DKK 200 mill which operated at constant returns to scale (CRS) in 1993 and 1994 showed increased returns to scale (IRS) during the following three years.

As mentioned before this could be an indicator of imminent structural changes in Denmark and that these changes especially will affect a number of small companies.

5. Concluding remarks

Data Envelopment Analysis (DEA) has been applied to the insurance industries of the four Nordic countries, Denmark, Finland, Norway and Sweden. Productivity differences between insurance companies from different countries have been measured by Malmquist indices and decomposed into one term describing different distances from the national best practice frontiers and another describing the difference between these national frontiers. The Malmquist index has also been applied to compute the productivity gains in the insurance industry over the 1993-97 period.

During the study period 1993-1997 the Nordic property liability insurance market has changed from being segmented national markets through deregulation towards emerging internationalization, which will result in increased competition and the formation of new financial constructions.

Internationally the Nordic property liability market, which until now has not been described against a uniform statistical background, is considered as one single market. However, the conclusion to be drawn from this study is that the national Nordic insur-

ance markets differ far more widely than believed so far. Each individual market is highly influenced by national economic and political factors and major differences exist both between the Nordic insurance markets and between individual companies.

At the company level all Nordic companies seem to be undergoing a certain uniform step by step development with the first step being national mergers and fusions focusing on volume growth, cost reduction and economies of scale.

The second step seems to focus on the exploitation of scope advantages by joint distribution through banks, mortgage credit institutions and insurance companies either by way of mergers and fusions or by way of strategic alliances.

The last step of this three step development process is bound to take place on the international level with activities focusing on size, financial strength and cost reductions, a step which seems to have been taken only very recently.

Notes

- ¹ A part of the collected data has been published as a supplement to NFT 3/1999.
- ² The nonparametric framework has previously been applied to insurance sector data by Bukh and Knie-Andersen (1999), Fecher *et al.* (1993), Cummins *et al.* (1995a), Cummins *et al.* (1995b) and Cummins and Zi (1997).
- ³ A more thorough description of the calculations can be found in Färe *et al.* (1985, 1994).
- ⁴ In this report the input-based measure will be used. The definition of the output-based measure, based on scaling the output vector, follows straightforwardly from applying the output-increasing Farrell efficiency measure, see Førsund (1990).
- ⁵ Bjurek (1994) proposes a solution to this problem in the VRS case by redefining the Malmquist index to a new Malmquist Total Factor Productivity index by forming the ratio

between Malmquist output and input quantity indices as defined in Caves *et al.* (1982b).

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