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MEASURING PRODUCTIVE PERFORMANCE IN THE NON-LIFE INSURANCE INDUSTRY: The case of French and Belgian markets

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ABSTRACT

This paper provides an assessment of the relative productive performance of Belgian and French non life insurance companies. We use both a parametric and a non parametric approach to construct a frontier to be used as a yardstick of productive efficiency. Our data basis covers 434 companies for the period 1984-88, 243 for France and 191 for Belgium. First, the French and the Belgian markets are studied separately and then, they are merged. The main findings show a high correlation between parametric and non parametric results, a wide dispersion in the rates of inefficiency across companies and a significant effect of scale, institutional form, reinsurance, claims to premiums ratios and car ratio on efficiency. On average, French companies are more efficient than the Belgian ones.

1. Introduction

As the completion of the internal market is getting close, a number of EEC member countries are rightfully concerned by the performance of their insurance industry. In the famous report on the "Cost of Non-Europe"[1] one finds quite striking price differentials for life and non-life insurance across eight EEC countries. Many objections have been raised towards such results. We all know how much caution is needed for a meaningful price comparison. It remains that such discrepancies cannot but call for some explanation pertaining to national regulation, scale economies, market structure and productive efficiency.

This paper addresses the issues of productive efficiency and optimal scale of the non-life insurance industry in two European countries : Belgium and France. We believe that differentials in scale economies and productive inefficiency are factors which might explain those price differentials and which could endanger the whole insurance industry in countries with higher prices.

To measure firms' efficiency, we use two alternative methodologies to construct a production frontier, that is the maximum possible outputs which can be produced from given quantities of a set of inputs. The indicator of productive, also called technical, inefficiency is given by the relative distance between this frontier and the input-output vector of actual production in a given company. To measure economies of scale, we just exploit the properties of the best practice frontier so constructed.

Our estimations are based on a panel of 243 French and 191 Belgian companies for the period 1984-88. For the sake of comparison, this data set is slightly different from that used in previous papers dealing with those two countries separately.[2] Those differences may explain why some of the results presented here are at slight variance with those one can find in those two papers.

The outline of this paper is as follows. In section 2, we present our data base and we specially discuss our choice of premiums as an indicator of output. In section 3, the efficiency indicators are given and controlled for by the firms' characteristics; further, the scale elasticities are derived. The conclusions are presented in a final section.

[1] Emerson *et al.* (1988).

[2] Fecher *et al.* (1992) and Delhausse and Hamende (1992).

2. The data set

2.1. Structure of the non-life insurance sector in Belgium and France

Not surprisingly, the French market is disproportionately larger than the Belgian one. We kept, for the years 1984 to 1988, 243 companies for France and 191 for Belgium[3]. Table 1 gives a description of the non-life insurance market in both countries as well as the result of merging them. French insurance market is dominated by non-profit companies, state-owned and mutuals, which comprise eight of the top ten companies. Non-profit companies are less frequent and less big in Belgium. The average scale as measured by gross premiums is 5 times higher in France than in Belgium. Both countries are largely open to foreign competition.

Insert Table 1 and Figure 1

In both countries, the market is heterogenous and highly segmented. This can be perceived by looking at the wide dispersion across companies of basic characteristics such as the distribution ratio (proportion of commissions paid in total costs incurred), the reinsurance ratio (proportion of reinsurance ceded in total gross premiums), the claims ratio (ratio of claims to gross premiums) and the car ratio (relative share of motor insurance premiums). In fact, those characteristics will be used below to explain part of the low efficiency levels that we obtain. The distributions of these ratios across companies are given in Table 1 and in Figure 1.

Like in most countries car insurance is compulsory in Belgium and France and then differenciated from other types of insurances. As we can see from Figure 1, less than 50% of the observed companies operate in the car insurance market and only few of them are specialized in this activity.

Concerning the other ratios depicted in Figure 1, we see that even if many companies show similar profiles, the heterogeneity is quite large. For instance, one can find in both countries a lot of enterprises with high distribution and reinsurance ratios as well as a great number of firms that don't make use of reinsurance opportunities and of intermediaries.

Finally, concerning the claims ratio we see again a variety of situations. If we assume that a high claims ratio is an indicator of the efficiency of insurance companies in the management of their portfolio of risks, one can expect that technical efficiency and the claims ratio will be positively correlated.

[3] The data was available from the French Federation of Insurance Companies (FFSA) and from the Belgian Control Office of Insurance Companies (OCA) that we acknowledge. From original samples of 331 French non-life insurance companies and 343 Belgian firms, we have come down to 243 and 191 companies respectively, dropping observations which looked unreliable or which concern too small companies (annual gross premiums below 30 millions of Belgian Francs).

The data presented in Table 1 and Figure 1 come from profit and loss accounts as well as each company's balance sheet sources.[4] The output variable we used is gross premiums. Labor costs are used as a proxy for the labor force; they include commissions paid to intermediaries who sell insurance without being formally employed by the company. As an additional input we use a composite item consisting of various outlays such as capital consumption, purchase of equipment and supplies. These choices are dictated by data availability; they don't come without problems, specially the choice of premiums as an indicator of output.

2.2. The output of an insurance company

The data requirement of productive efficiency measurement is rather minimal : a set of input-output vectors, each characterizing the actual operations of a number of production units. In particular, it does not impose comparability of inputs and allows for introducing qualitative aspects. When studying the insurance industry input data does not seem to raise any problem but of availability. Insurance companies mainly use various skills of labor, equipment and buildings.

The real difficulty, both conceptual and statistical, lies in measuring the production of the insurance industry.[5] In the case of a typical manufacturing industry, real output in a given year is measured by taking the number of various types of products produced. If one wants to aggregate them in a single output indicator, one takes a weighted average of those quantities with the respective product prices in some designated base year being used as a weight. In the case of the insurance sector, matters are less simple. As Horstein and Prescott (1991, p.197) explain, "*there is not even a conceptual definition of the output to guide the construction of a reasonable measure of its product. Without a conceptual measure, it is not clear what data should be collected and how they should be used to compute an output measure*".

The first to be interested by the issue of output measurement are the national income accountants. In a number of countries, insurance production is no more than an index of labor input. It happens that instead one uses operating expenses deflated by a composite price index. Needless to say that as a direct implication calculation of productivity change then turns out to be a tautological exercise. Economic research has rarely dealt with the mere issue of output measurement. It has rather concentrated on the estimation of scale economies and more recently of scope economies. In most studies, premiums earned are used as a proxy for output.

In the U.S., inputs are not used to extrapolate real product. In the non-life insurance

[4] The data are given in Belgian Francs ($ 1 = 34 BF). They are deflated by the OECD price index for financial services. Base year is 1985.

[5] See, on this, O'Brien (1991), Hornstein and Prescott (1991), Hirshorn and Geehan (1977).

sector, premiums are used for assessing nominal output. They are then deflated by a consumer price index to yield real insurance output. This is the approach we adopt here while being aware of its pitfalls well illustrated by Hornstein and Prescott (1991).

We however believe that this approach which is dictated by data availability makes economic sense. After all, what an insuree buys is clearly some kind of protection against contingencies specified in a contract. The premium they pay represents the value they attribute to such protection. If they could choose, they would rather receive nothing back from their insurance company, implying that the contingencies against which they sought protection didn't occur. Pursuing the comparison with the automobile market, the price one pays for a car reflects the value given by the buyer to that car and even though that price includes a guarantee, the consumer would rather not have to use that guarantee.

All this means that using premiums to measure the output of an insurance company makes sense at the level of individuals and assuming competition among companies. If there were no competition, an inefficient firm could charge an insured person a relatively high premium without providing higher protection than it would be possible at lower price with less profits and less X-inefficiency in a competitive setting. As to the aggregation problem, it is clear that group insurance costs less than individual insurance without providing less protection. When using gross premiums as an indicator of output we have to assume that there is some competition and that the distribution of individual versus group policies is about the same across companies.

If data were available, matters would be different. One could then use either a latent variable approach or an hedonic approach to the measurement of insurance contracts. In the case of automobile insurance, one would need information on the amount of coverage, the deductibility level, the nature of the use of the car and the car model being insured as well as each insured's characteristics. All these features which could be determined by an examination of standard contracts would allow a much more satisfactory measure of the insurance output. At this moment, publicly available data are too limited to carry out such a measurement exercise. Henceforth, we have to do with a second best approach that consists of relying on premiums.

3. Productive efficiency and scale elasticities

3.1. Firm-specific productive efficiency

To assess production efficiency, we use two approaches.[6] The first one is the parametric maximum likelihood (ML) procedure proposed by Battese and Coelli (1988). Specially designed to deal with panel data, this procedure amounts to estimating the conditional expectation of the individual companies efficiency under the assumption of a truncated normal distribution. The second approach is the non-parametric Data

[6] See Pestieau and Tulkens (1990).

Envelopment Analysis (DEA) with variable elasticity of scale and with an output-based measure of efficiency. In either method, total premiums are used as output and both labor costs and composite costs are used as inputs.

An important characteristic of the data lies in its unbalanced nature resulting from mergers and from market entries and exits. The ML approach is perfectly adapted to deal with unbalanced data[7] but this is not the case for the DEA approach that is currently applied either on cross-section or on longitudinal data. In order to overcome this difficulty we adopt an approach that consists in the estimation of an unique DEA frontier for the whole panel data assuming that the available technology didn't change over the analyzed period.

In order to estimate the parametric production frontier, the specification we adopt is a translog function of the form :

(1) $y_{it} = \alpha + \beta_1 x_{1,it} + \beta_2 x_{2,it} + \beta_{11} x^2_{1,it} + \beta_{22} x^2_{2,it} + \beta_{12} x_{1,it}x_{2,it} + \varepsilon_{it}$,

where y_{it}, $x_{1,it}$ and $x_{2,it}$ indicate the logarithmic deviations from means values for gross premiums, labor and composite input costs, respectively, corresponding to firm i (i=1,...,I) and year t (t=1,...,T). The α, β_k and β_{kk} (k=1,2) are parameters to be estimated jointly with the variance (σ^2) of the composed error term $\varepsilon_{it}= - \mu_i +v_{it}$, where $\mu_i \geq 0$ indicates the specific technical inefficiency and v_{it} a random term with the usual properties ($N[0,\sigma_v]$), and with the share of inefficiency in total error variance $\gamma=\sigma^2_\mu/\sigma^2$.

Insert Table 2

On table 2, the estimated coefficients of the translog production frontiers are given for the three samples : Belgian, French and the merged one. For the sake of homogeneity and comparability we assume in all cases that individual inefficiency is constant over time and follows a normal distribution truncated at zero. One can see that in the three cases the estimated share of inefficiency in the total error variance (γ) is higher than 95%. This fact is in accordance with the wide distribution of estimated inefficiencies as it will be showed later.

Not surprisingly, both the level and the significance of coefficients are close for the French and the merged sample of companies. For the Belgian sample that is smaller and covers a reduced scale range, the results obtained are slightly different except for the second order terms that are not statistically significant at all.

Under the non parametric DEA approach, technical efficiency for firm *r* and period *s* is obtained as the ratio between the weighted output and the sum of weighted inputs

[7] The program used for the ML estimations was developed by Coelli (1991).

subject to the condition that for the other observations in the panel this ratio is equal or inferior to one. In other words :

(2) $$\max h_{rs} = \frac{u\, y_{rs} + w}{v_1\, x_{1,rs} + v_2\, x_{2,rs}} ,$$

$$\text{subject to : } \frac{u\, y_{it} + w}{v_1\, x_{1,it} + v_2\, x_{2,it}} \leq 1, \forall i \neq r , \forall t \neq s ,$$

$$u, v_1, v_2 \geq 0, \text{ and } \infty > w > -\infty ,$$

where u, v_1 and v_2 are the weights that constitute the variables of the problem, jointly with w that allows for variable returns to scale (w = 0 for constant returns to scale). This problem is then solved for each firm and period by the way of a linear programming technique as it was first proposed by Charnes, Cooper and Rhodes (1978).

Insert Table 3

The results corresponding to both approaches are given in Table 3 for each national sample and for the merged sample. Overall efficiency is given as well as efficiency for each institutional type of companies. Note that the DEA results, even if they are estimated yearly, are represented by the firms' average values over the period in order to be comparable with the ML results.

Insert Figure 2

Overall efficiency is quite low in the three cases, particularly when using DEA. The correlation between the ML and the DEA measures is high. The dispersion of the efficiency indicators is wide as indicated by either their standard deviation or their range values. Non-profit companies are consistently the most efficient but no clear conclusions can be drawn from the comparison between national and foreign for-profit companies.

To compare DEA with ML results, we can look at Figure 2 which provides a graphical distribution of the two measures. The general pattern is the same. The measure based on the parametric approach has a distribution to the right of the other.

3.2. Efficiency measures and companies' characteristics

The efficiency indicators reported on Table 3 are rather low and widely dispersed. One can conjecture that if dispersion was narrower, average efficiency would also be higher. As mentioned above, the insurance market is very segmented in Belgium and in France and if we were controlling for this segmentation, the variance of our efficiency indicators could be reduced. For such control, we use as explanatory variables the characteristics of the companies, that is, the institutional form, the distribution ratio, the reinsurance ratio, the claims ratio, the car ratio, the scale and the country concerned.

Insert Table 4

Variance analysis is used. The results are given in Table 4 for both types of indicators and for the three samples. The multiple correlation coefficients given in the bottom of Table 4 indicate that all the characteristics taken together explain near 40% of the estimated efficiency variance, with the only exception of the non parametric indicator for Belgium that amounts 31.5%.

Focusing on the estimators obtained from the merged sample, one sees that Belgium is on average less efficient that France by 0.078 and 0.104 for the ML and DEA approaches respectively. We also note that the non-profit form is the most efficient with rates that are close to 10%. Moreover scale appears as an important factor explaining insurance efficiency, the big companies seem the best suited to improve performance.

Finally, the influence of the four ratios assumed to be indicators of the market segmentation are significant in the most cases. As expected, firms with high claims to premiums ratio tend to be more efficient as it is also the case for companies with high reinsurance rates, except for the French sample. Also companies specialized in car insurance tend to be less efficient. Concerning the distribution ratio, the results are conflicting except for the positive and significant influence of high distribution ratios on DEA efficiency indicators. Note that these results are consistent with those obtained in a study on the French insurance market [Fecher *et al.* (1992)].

3.3. Scale economies

One of the most lively areas of applied research on the insurance industry is that dealing with the optimal size of insurance companies. In a recent survey, Lahaye *et al.* (1990) show that one generally observes slight economies of scale. On the basis of the estimates of the translog production frontiers presented in Table 2, one can compute for each firm and period the corresponding scale elasticities. The average values obtained for each sample are given in Table 5.

Insert Table 5

The figures reported in Table 5 indicate slight differences in average scale elasticities for the three samples, they are close to 0.93. The elasticities with respect to inputs are in all cases around 0.70 and 0.20 for labor and for the composite input respectively. Further, those elasticities increase with the scale of companies indicating that only the greatest firms in the sample, with gross premiums income higher that 2 billions BF (near $ 60.0 millions), reach the optimal size.

4. Conclusions

The main contribution of this paper is to provide productive efficiency measures and scale elasticites for a merged sample of Belgian and French non-life insurance companies. The most striking results can easily be summarized :

(i) efficiency levels are low and widely dispersed;
(ii) non-profit companies are more efficient than for-profit companies;
(iii) French companies are on average quite more efficient than Belgian ones;
(iv) market segmentation, tested by four representative ratios, seems to be an important factor explaining efficiency variance;
(v) scale elasticities increase with companies' scale; they are generally inferior to unity.

This study is a step towards a comprehensive efficiency comparative study of the EEC insurance market. Such comparison is desirable in a period of increasing integration of insurance markets and of concern for countries having inefficient companies with a too small dimension. One should however realize that any step towards enlarging our sample of companies has a price : it makes even more difficult not using as output indicator gross premiums.

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Table 1
Structure of non-life insurance
(average values for 1984-88)

Firms characteristics	Firms n	(%)	Gross premiums MBF	Distribution ratio %	Reinsurance ratio %	Claims ratio %	Car ratio %
			Belgian sample				
Institutional form							
Non-profit	20	(10.5)	946.0	12.6	20.9	66.0	7.9
Stock	110	(57.6)	1418.0	40.7	30.0	62.7	26.5
Foreign	61	(31.9)	361.0	51.6	31.5	70.6	9.0
Scale[1] (MBF)							
30-200	83	(43.4)	91.0	42.4	33.6	65.0	9.1
200-600	40	(20.9)	368.8	41.4	33.3	64.4	19.7
600-2000	43	(22.5)	1096.5	40.2	24.3	67.2	31.1
2000-	25	(13.1)	5098.7	38.8	19.1	66.9	30.0
All	191	(100.0)	1031.0	41.2	29.5	65.6	19.0
			French sample				
Institutional form							
Non-profit	90	(37.0)	8542.1	40.5	36.3	48.5	27.7
Stock	75	(30.9)	5943.7	53.7	37.4	43.6	25.9
Foreign	78	(32.1)	768.8	74.8	35.1	51.5	6.8
Scale[1] (MBF)							
30-200	58	(23.9)	102.0	68.3	39.6	46.5	4.3
200-600	49	(20.2)	377.4	60.4	43.7	38.5	13.2
600-2000	57	(23.4)	1138.1	49.9	39.5	45.1	25.1
2000-	79	(32.5)	15003.1	47.4	26.8	56.9	33.5
All	243	(100.0)	5244.9	55.6	36.2	47.9	20.5
			Merged sample				
Institutional form							
Non-profit	110	(25.3)	7161.0	35.4	33.5	51.7	24.1
Stock	185	(42.6)	3252.7	45.9	33.0	55.0	26.3
Foreign	139	(32.1)	589.8	64.6	33.5	59.9	7.8
Scale[1] (MBF)							
30-200	141	(32.5)	95.5	53.1	36.1	57.4	7.1
200-600	89	(20.5)	373.5	51.8	39.0	50.2	16.1
600-2000	100	(23.0)	1120.3	45.7	32.9	54.6	27.7
2000-	104	(24.0)	12622.2	45.4	25.0	59.3	32.6
All	434	(100.0)	3390.4	49.3	33.3	55.7	19.8

[1] Measured by gross premium income in Millions of Belgian Francs (MBF).

Figure 1
Some non-life insurance ratios

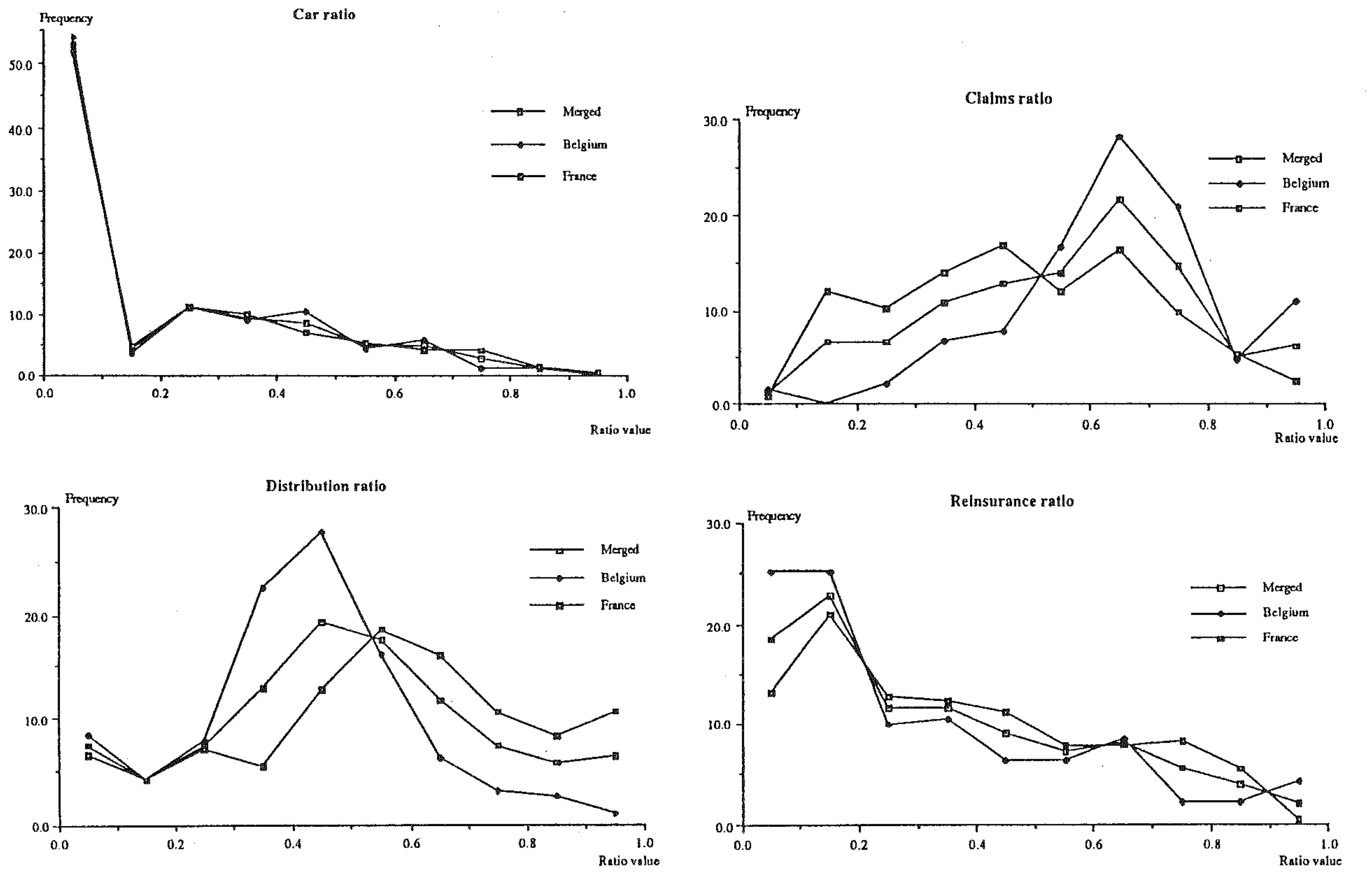


Table 2
The translog production frontier[1]
ML estimators[2]

Variables[3]		Parameters	Belgium sample	French sample	Merged sample
x_1	Labor	β_1	0.805 (46.0)	0.704 (50.4)	0.719 (67.3)
x_2	Composite input	β_2	0.124 (7.1)	0.238 (19.5)	0.207 (22.5)
$x_1 \cdot x_2$		β_{12}	-0.005 (0.3)	-0.087 (7.5)	-0.054 (5.3)
x_1^2		β_{11}	0.016 (1.4)	0.046 (7.4)	0.030 (5.2)
x_2^2		β_{22}	0.008 (0.6)	0.046 (8.1)	0.036 (6.7)
1	Intercept	α_0	0.599 (21.9)	0.611 (29.5)	0.676 (36.4)
Composed error variance		σ^2	0.540 (10.8)	0.561 (9.7)	0.663 (13.6)
Share of efficiency in total error variance		γ	0.967 (239.2)	0.980 (410.6)	0.978 (499.7)
Log likelihood function			145.8	412.2	509.0
$\chi^2_{(d.f.=7)}$			833.8	1320.7	2196.0
Number of observations			869	1093	1962
Number of firms			191	243	434
Number of iterations			31	22	23

[1] Equation (1) in section 3.1.

[2] The t-tests are reported in parentheses.

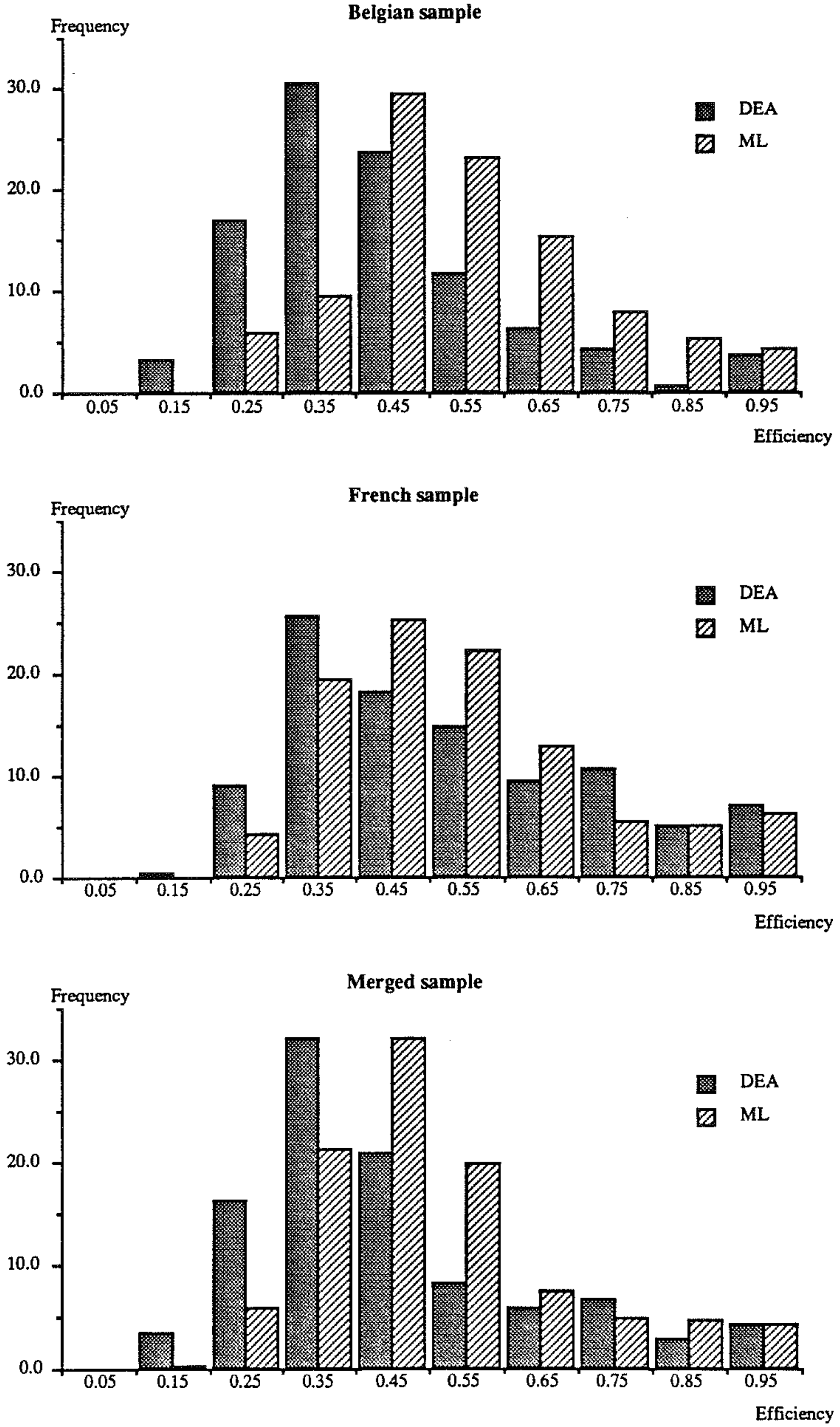
[3] All the variables are expressed in logarithmic deviations from means values.

Table 3
Firm-specific efficiency measures
(average values for 1984-88)

	n	Parametric ML	Non-parametric DEA[1]
Belgian sample			
Mean	191	0.547	0.431
Institutional form			
Non-profit	20	0.656	0.521
Stock	110	0.510	0.434
Foreign	61	0.579	0.396
Standard deviation		0.162	0.172
Range : minimum		0.207	0.122
maximum		0.989	0.995
Spearman rank correlation			
ML		1.000	0.668
DEA			1.000
French sample			
Mean	243	0.539	0.527
Institutional form			
Non-profit	90	0.616	0.577
Stock	75	0.504	0.491
Foreign	78	0.485	0.506
Standard deviation		0.175	0.201
Range : minimum		0.243	0.192
maximum		0.987	0.997
Spearman rank correlation			
ML		1.000	0.863
DEA			1.000
Merged sample			
Mean	434	0.506	0.447
Institutional form			
Non-profit	110	0.612	0.541
Stock	185	0.469	0.410
Foreign	139	0.471	0.421
Standard deviation		0.169	0.191
Range : minimum		0.136	0.114
maximum		0.989	0.997
Spearman rank correlation			
ML		1.000	0.845
DEA			1.000

[1] Firms' efficiency is averaged over the period.

Figure 2
Efficiency measures[1]



[1] The levels of efficiency are aggregated in deciles indicated by the middle-class values.

Table 4
Variance analysis of efficiency indicators [1]

Characteristics[2]	Belgian sample		French sample		Merged sample	
	ML	DEA	ML	DEA	ML	DEA
Intercept	0.362*	0.191*	0.363*	0.308*	0.304*	0.242*
<u>Countries</u>						
France	------	------	------	------	ref.	ref.
Belgium	------	------	------	------	- 0.078*	- 0.104*
<u>Institutional forms</u>						
Stock	ref.	ref.	ref.	ref.	ref.	ref.
Non-profit	0.159*	0.100*	0.097*	0.081*	0.125*	0.099*
Foreign	0.052*	- 0.010	0.009	- 0.002	0.019	- 0.005
<u>Distribution ratio</u> (%)						
0-50	ref.	ref.	ref.	ref.	ref.	ref.
50-75	0.068*	0.054	- 0.080*	- 0.022	- 0.025	0.013
75-100	0.011	0.145*	- 0.004	0.131*	- 0.003	0.146*
<u>Reinsurance ratio</u> (%)						
0-20	ref.	ref.	ref.	ref.	ref.	ref.
20-50	0.021	0.095	0.036	0.027	0.036*	0.020
50-100	0.113*	0.101*	0.059	0.041	0.096*	0.050*
<u>Claims ratio</u> (%)						
0-30	ref.	ref.	ref.	ref.	ref.	ref.
30-50	0.004	- 0.128*	0.043	0.051	0.088*	0.076
50-75	0.119*	- 0.076	0.136*	0.172*	0.174*	0.178*
75-100	0.139*	- 0.065	0.224*	0.253*	0.225*	0.206*
<u>Car ratio</u> (%)						
0	ref.	ref.	ref.	ref.	ref.	ref.
0-40	- 0.085*	- 0.073*	- 0.052*	- 0.052*	- 0.080*	- 0.071*
40-100	- 0.098*	- 0.085*	- 0.049	- 0.050	- 0.077*	- 0.064*
<u>Scale</u> (gross premiums MBF)						
30-200	ref.	ref.	ref.	ref.	ref.	ref.
200-600	0.039	0.007	0.030	- 0.014	0.051*	0.031
600-2000	0.096*	0.033	0.111*	0.075*	0.129*	0.122*
2000-	0.086*	0.009	0.195*	0.208*	0.185*	0.242*
Multiple correlation coefficient	0.377	0.315	0.445	0.445	0.402	0.503
Number of firms	191	191	243	243	434	434

[1] All the variables are expressed in average values for 1984-88.

[2] The categories were choosen to be the more representative (see Table 1 and Figure 1).

* Statistically significant ($Pr[\alpha=0] \leq 0.05$) on the basis of a t-test.

ref. : Indicates which group is the reference one.

Table 5
Elasticities of scale[1]
(average values for 1984-88)

Scale[2] (MBF)	Firms	Elasticities w.r.to Labor	w.r.to Composite input	Scale elasticity
		Belgian sample		
30-200	83	0.682	0.203	0.885
200-600	40	0.712	0.205	0.917
600-2000	43	0.727	0.216	0.943
2000-	25	0.731	0.247	0.978
All	191	0.705	0.212	0.917
		French sample		
30-200	58	0.730	0.146	0.876
200-600	49	0.727	0.188	0.915
600-2000	57	0.731	0.208	0.939
2000-	79	0.735	0.251	0.986
All	243	0.731	0.204	0.935
		Merged sample		
30-200	141	0.701	0.180	0.881
200-600	89	0.720	0.196	0.916
600-2000	100	0.729	0.211	0.940
2000-	104	0.734	0.250	0.984
All	434	0.720	0.208	0.928

[1] For each firm and period the corresponding elasticities are calculated using the translog estimators presented in Table 2.

[2] Gross premium income in Millions of Belgian Francs (MBF).