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Performance of the Dutch non-life insurance industry: competition, efficiency and focus

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Abstract
This paper investigates competition in the Dutch non-life insurance industry indirectly by measuring scale economies and X-inefficiency, assuming that strong competition would force insurance firms to exploit unused scale economies and to push down inefficiencies. We observe substantial economies of scale (on average 11%) that are larger for smaller firms. Despite considerable consolidation in the industry over the last decade, scale economies have increased, as the optimal scale has outgrown the actual one. Comparing estimates across aggregation levels, we find that scale economies are smaller for groups and lines of business than they are for firms. Besides scale, focus and organizational form are important cost determinants as well: generally, specialized insurers have lower costs and face greater economies of scale. Estimates of thick frontier efficiency point to huge cost differences across firms and within lines of business. Overall, our results suggest that there is a lack of competitive pressure in the Dutch non-life insurance industry.

Keywords: Non-life insurance, economies of scale, market structure, concentration, competition, X-efficiency, total cost function, aggregation: insurance groups, firms and lines of business;

JEL classification: D4, D61, G22, L1;

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1 Introduction

During the past few decades, the financial services industry in Europe has changed drastically, due in part to the EU's financial services deregulation. In 1994, the Third Generation Insurance Directive (TGID) deregulated the European insurance market. Since then, European insurance firms have been allowed to operate across national boundaries via a 'European passport', which aims at encouraging foreign competition. Moreover, they are now free to develop new products and to set prices at their discretion.

In formerly highly regulated countries, deregulation meant a distinct break with the past. A prime example is Germany where prices used to be regulated for the entire industry, enabling the most inefficient providers to remain in the market. In fact, efficient German insurance firms used to face a penalty for good performance. Before 1994, profits over 3% of premium income had to be divided between policyholders and shareholders, with at least 90% going to policyholders through terminal bonuses (Rees and Kessner, 1998). Although this regulatory scheme created a stable and transparent market for consumers, price competition was weak, and product choice was limited.

By contrast, in traditionally less regulated countries, like the Netherlands and the United Kingdom, the regime change had limited impact. The TGID transmitted a regulatory model similar to that of the Netherlands across Europe, fostering a level playing field, except where solvency regulation was concerned. Nonetheless, even in the Netherlands the insurance industry has undergone considerable structural changes in recent years. In the Dutch non-life industry, the number of firms dropped by more than 20% between 1995 and 2005, and average firm size increased by almost 100% in real terms.

This paper aims at establishing to what extent economies of scale and X-efficiency have been drivers behind the ongoing consolidation trend in the Dutch non-life insurance industry. The existence of substantial unused economies of scale would indicate insufficient competitive pressure to improve cost efficiency. Suret (1991) reports economies of scale for the Canadian property and casualty insurance industry, whereas Fecher *et al.* (1991) find modest economies of scale in the French non-life industry of 4%. Hirao and Inoue (2004) examine the Japanese non-life insurance industry and find significant economies of scale for Japanese insurers. Cummins and Weiss (1993) show for the US Property-Liability (P-L) insurance market that small and medium-size firms are characterized by substantial economies of scale, in the range of 20%, while large firms exhibit mild scale diseconomies of 7%. Their result is broadly replicated by Hanweck and Hogan (1996) who also find that small US P-L firms face economies of scale, and large firms experience diseconomies of scale. Cummins and Rubio-Misas (2006) investigate the insurance operations of Spanish firms and similarly conclude that scale economies largely disappear for firms in the largest size quartile. Toivanen (1997), however, reports diseconomies at the firm level for the Finnish non-life insurance industry. Further, we estimate cost X-efficiencies of the non-life insurers, also to assess indirectly whether competition force insurers to improve their efficiency. Cummins and Weiss (2000) report that average cost efficiency for the US P-L industry ranges from 0.39 to 0.86. For France, Fecher *et al.* (1993) find average cost efficiency of 0.41 for P-L insurers. Our paper is the first to investigate scale economies, competition and X-efficiency in the Dutch non-life insurance industry.

The remainder of this paper is structured as follows. Section 2 discusses the structure of the Dutch non-life industry and Section 3 describes the data. Section 4 introduces the model that explains operational costs and presents the variables used in our empirical analysis. Section 5 provides estimates of this model under the assumption that all firms operate independently from each other. Section 6 estimates economies of scale over time, while Section 7 makes a distinction between economies of scale for monoline and multiline insurers. Section 8 gives estimates of scale economies on various levels of aggregation: lines of business level, firm level and insurance group level, assuming that firms within these groups coordinate fully. Section 9 evaluates the cost inefficiency of the Dutch market, by examining estimates of thick frontier efficiency. Finally, the last section sums up and draws conclusions.

2 Structure of the Dutch non-life insurance industry

The Netherlands has quite a sizeable non-life insurance industry. Both in terms of per-capita non-life premiums (€ 1400) and premium income to GDP (4.3%), the Netherlands ranks fourth world-wide.[2] At year-end 2005, 234 registered non-life insurance firms offered their services to the Dutch consumers and businesses. About half of these firms are affiliated to one of the 21 insurance groups (holdings made up of a number of firms), which control about 73% of the market. The majority of these affiliated firms make their own decisions on pricing and strategy. Therefore, we investigate not only the insurance groups (assuming full dependency of these affiliated firms) but also consider, alternatively, these affiliated firms as 'independent' entities.

Intermediaries, comprising both tied and multiple agents, constitute by far the most important distribution channel in the Netherlands, capturing more than 50% of premium income in recent years. This percentage is high compared to that in other large European markets such as

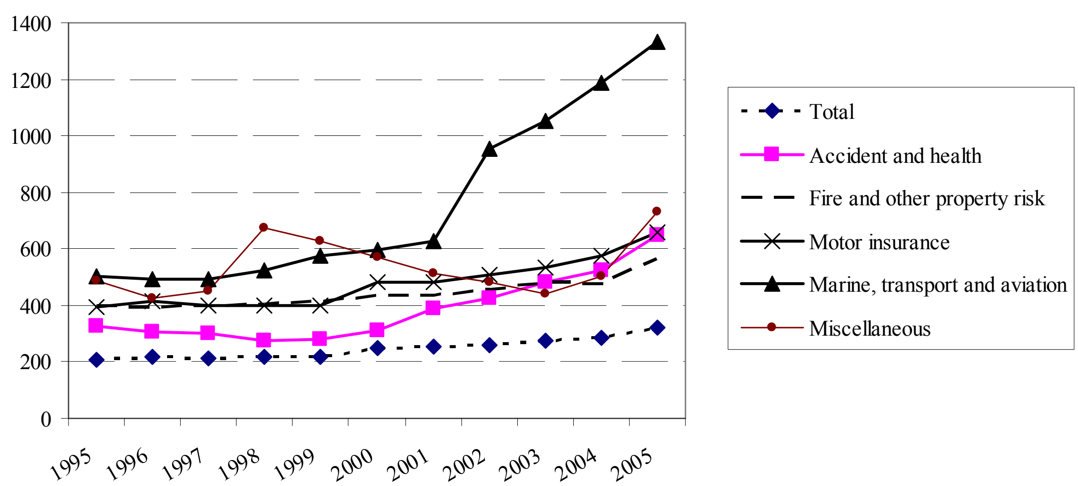
[2] Figures from Swiss Re (2006).

Germany and the UK, where less than 20% is sold via intermediaries. Only a minor part of non-life policies (of about 10%) is sold via related banks.

The non-life industry is composed of five major lines of business: (i) accident and health, (ii) motor, (iii) marine, transport and aviation, (iv) fire and other property risk, and (v) miscellaneous insurance. Accident and health insurance is the most important line of business accounting, in 2005, for 48% of total revenues, whereas motor insurance and fire and other property risk insurance had shares of 20% and 14%, respectively, leaving 18% for the remaining lines of business.

Ongoing consolidation is an important feature of the Dutch non-life industry. Figure 1 presents Herfindahl-Hirschman concentration indices (HHIs), defined as the sum of squared market shares, based on premium income of lines of business over 1995-2005, and calculated at the firm level. The indices increase substantially over the sample period, both for the entire industry and for the individual lines of business. Consolidation is highest in the marine, transport and aviation insurance lines of business (both in levels and in numbers of changes), where competition and efficiency are fostered by the presence of well-informed and cost conscious buyers (business firms), some of which have the alternative of self-insuring. This could point to scale economies as a major driver behind the consolidation trend.

Figure 1. HHIs for the Dutch non-life insurance industry (aggregated as well as by line)



The upper panel of Table 1 presents market shares of the largest 5, 10 and 20 firms for the entire non-life insurance industry, based on premium income. These measures of market concentration increased between 1995 and 2005. The top-five insurers account for virtually the entire rise in market concentration, indicating that they have dominated the restructuring of the non-life insurance industry. Furthermore, we observe that the market share of firms that operate in two or more lines of business – *i.e.* multiline insurers – has decreased over the sample period, while the market share of monoline insurers has increased (last two columns of Table 1, upper panel). Hence, restructuring in the Dutch non-life insurance industry is also characterized by strategic focus, that is, specialization instead of conglomeration. Specialized insurers are better positioned to serve the many niche markets.

Table 1. Number of non-life insurance groups and firms and their respective market shares

	Market share (in %)					
Year	*Groups*	*Largest 5 firms*	*Largest 10 firms*	*Largest 20 firms*	*Monoline firms*	*Multiline firms*
1995	77	23	37	55	34	66
2000	74	27	40	58	30	70
2005	73	31	47	68	42	58
	Number of groups and firms					
	Groups	*Affiliated firms*	*Unaffiliated firms*			
1995	33	161	101			
2000	28	141	103			
2005	21	102	103			
	Number of firms split up by number of lines of business					**Avg lines per firm**
	1 line	*2 lines*	*3 lines*	*4 lines*	*5 lines*	
1995	154	14	11	28	55	2.30
2000	157	9	13	26	39	2.10
2005	135	9	6	23	32	2.06

The middle panel of Table 1 shows the number of non-life insurance firms and groups.[3] During the sample period, the number of non-life groups decreased from 33 to 21, while the market share of these groups dropped only slightly (from 77% to 73%). Average group size has thus increased substantially, as groups have taken over other groups and, hence, their affiliated firms. This is also reflected by the decline of the number of affiliated firms over our eleven year sample period. By contrast, the number of unaffiliated firms has remained remarkably stable over the years. Apparently, consolidation has been strongest within insurance groups. Note that the stable number of unaffiliated firms does not imply limited market dynamics. In fact, viewing the inflow and outflow of these firms, we observe that, on a total of around 103 companies, 48 firms entered the market during 1995-2005, 48 firms left, 10 firms joined an insurance group, while 12 left one.

The lower panel of Table 1 presents the number of firms split up by the number of lines of business they operate in. Here we observe that monolines are by far most widespread, followed

[3] After selection, see next section.

by multilines that operate in 4 or 5 lines of business. The number of monoline insurers is relatively large, because these firms are both easier to establish (less regulatory requirements) and easier to manage. Indeed, of the entrants between 1995 and 2005, almost 80% started off as monolines. Considering developments over time, we observe that the number of firms that operate in two or more lines of business decreased more rapidly (by 35% in eleven years) than the number of monoline insurers (which fell by 12%). Again, we find that consolidation is stronger among multiline firms. As a result, the average number of lines of business per firm has decreased.

3 Description of the data

For our analysis we use a detailed dataset on all Dutch non-life insurers during the period 1995-2005 stemming from De Nederlandsche Bank (DNB), the prudential supervisor of insurance firms in the Netherlands. The initial dataset consists of 2994 firm-year observations, of which we have excluded 296, because of missing data, on account of zero or negative values for premium income, incurred claims or total costs, or because costs exceeded premiums (*e.g.* run-off firms).[4] In monetary value terms the importance of these excluded firms is negligible. Exclusions from the analysis concern about 2% of the sum total of premiums and around 3 % of the sum total of claims. The dataset is an unbalanced panel due to mergers and acquisitions, terminations, new entrants and ‘selection’.

Table 2 gives summary statistics of our sample of Dutch non-life insurance firms for 2005, the most recent year available. The table shows four non-life key ratios as well as the frequency distribution of non-life insurers for different size categories, organizational forms and business models. The various distributions have been stable over the years. The inclusion of data from earlier years does not change the broad picture that emerges from the descriptive statistics in Table 2.

The upper part of Table 2 gives a breakdown by firm size in terms of premium income. The table indicates that the (weighted) average of total costs as a percentage of total premiums decreases substantially with increasing size, although the average increases somewhat in the highest but one category. About two-thirds of the firms in the smallest two size categories are mutual companies. This explains why acquisition costs for these size classes are much less important than for the other categories. Table 2 also indicates that larger firms tend to pay out (by

[4] The data source does not distinguish between missing data and zero values. We excluded 34 observations with negative values.

means of assigned claims) a larger proportion of premium income to their policyholders. Consequently, the (weighted) average combined ratio (that is, total costs plus total claims as a percentage of total premiums) is relatively constant across the size categories. Put differently, the data suggest that profitability and size are mutually unrelated. Apparently, high cost levels are sustainable, mainly thanks to low claim levels.

The middle part of Table 2 provides a breakdown by organizational form. We observe significantly higher (weighted) average costs for stock companies in terms of total premiums. As the average scale of mutuals is much smaller than that of stock companies, both organizational form and scale effects evidently explain cost differences across categories of non-life insurers. Note that mutuals' lower cost levels are compensated by higher claim ratios, resulting in comparable combined ratios for these firms.

Table 2. Key firm ratios by size classes, organizational forms and business models (2005)

	Total costs / premiums (%)	**Acquisition costs / total costs (%)**	**Total claims / premiums (%)**	**Combined ratio (%)***	**Number of non-life insurers**
	(1)	(2)	(3)	(4)	(5)
Size based on premiums (million euro)					
< 1	44	3	45	89	19
1 - 10	30	26	55	86	90
10 - 100	22	52	57	79	50
100 - 1,000	26	58	59	86	41
≥ 1,000	20	52	67	87	5
Total	*24*	*56*	*61*	*86*	*205*
Organizational form					
Mutual	14	23	73	88	101
Stock company	26	58	60	85	104
Business model					
Monoline	16	22	75	91	135
Multiline	30	68	51	82	70

Note: Figures in Columns 1, 2, 3 and 4 are weighted ratios, *i.e.* the sum of the numerators divided by the sum of the denominators.
* This ratio is defined as the sum of total costs and total claims, both as percentage of total premiums. Due to rounding, the sum of columns 1 and 3 may deviate from these figures.

Finally, the lower part of Table 2 displays the ratios by business model. We observe significantly lower average costs for monoline insurers, of 16% in terms of premiums, compared to 30% for multilines. Monolines spend less on acquiring new business, yet pay out a larger proportion of premiums to their policyholders. Consequently, once more we find that lower operational expenses by no means imply lower combined ratios, *i.e.* higher profits. As multilines are considerably larger, on average, than monolines, the choice of business model explains cost differences, given the scale of operations.

All in all, Table 2 reveals that scale effects, organizational form and business model are all drivers of firm costs. Nonetheless, a simultaneous approach, as presented below, is needed in order to determine the marginal contribution of each of these drivers more precisely.

4 Measuring scale economies: the model

We measure scale economies using a simple cost function. In the literature, the measurement and analysis of differences in insurance cost levels across non-life insurance firms is based on the assumption that the technology of individual firms can be described by a single production function. Under certain conditions, cost functions can be formulated which are the dual of the production function ('dual' refers to the property that production maximization is identical to cost minimization). Cost functions are often preferred because determinants of costs, such as prices, are more readily available than determinants of production, such as input volumes. In theory, such cost functions should include at least output volume and input prices. But while input cost figures are available, we do not observe the related input quantities and input prices. Incidentally, these input prices would probably be of limited if any use, because there is little or no price variation across firms in a small country such as the Netherlands. Gilligan and Smirlock (1984) and Kolari and Zardkoohi (1990) assume that efficiency wages and other factor prices are equal across all financial institutions. Note that the inclusion of price changes due to inflation would not add any useful information, whereas wage rate raises due to increased productivity would probably be insufficient to identify the true impact of wages on costs. Therefore, following the authors cited above, and Swank (1996) and Bikker (2001), we omit input prices. Although this simplification does not defeat our purpose, which is to measure the impact of scale on costs, in principle, we are no longer allowed to use theoretical properties related to the production function.

Our cost function reads as follows:

$$\ln \mathrm{TC}_{it} = \alpha + \beta_1 \ln \mathrm{output}_{it} + \beta_2 (\ln \mathrm{output}_{it} - \overline{\ln \mathrm{output}})^2 + \textstyle\sum_j \gamma_j \text{ control variables}_{ijt} + \varepsilon_{it}\,, \qquad (1)$$

where TC_{it} stands for total costs of non-life insurer i at time t, comprising operating expenses and distribution or acquisition costs. As the true insurance output is unobservable, we have to approximate this variable. In the insurance literature, both premiums and claims paid have been used many times, but both output measures have their shortcomings. The main weakness of premiums is that they represent revenue figures, *i.e.* prices times quantities, rather than volumes.

This would not be an actual problem if the insurance product were homogeneous and all insurance firms charged the same price, as in the case of perfect competition. However, as stated by Yuengert (1993), genuinely perfect competition would preclude the measurement of scale economies, since all firms would be on the optimum of the long-run horizontal average cost curve. In this respect, he states that 'systematic differences in prices across large and small firms may lead to misleading inferences about average costs, if premiums are used as an output proxy'. Apart from varying cost prices, diverging profit margins may also distort the measurement of output by premiums. Doherty (1981) and Skogh (1982) suggest that the use of gross premiums as an output measure may result in lower estimates of scale economies because premium rates tend to be negatively related to firm size.

The use of claims incurred would resolve these problems. As the essential service offered by non-life insurance firms is risk-pooling and risk-bearing, claims incurred would be a metric that is consistent with basic economic theory. Moreover, other services such as claims settlement provided by insurance firms are correlated with loss aggregates. Nonetheless, this empirical proxy also has its drawbacks (see Cho, 1989). First, the stochastic nature of non-life losses is likely to create an 'errors-in-variables problem' that would distort the measurement of scale economies, particularly where the insurance includes catastrophe risk. Second, when claims incurred are used, the output quality of loss control and risk management is ignored, which is undesirable. As a result, an insurer that is very successful in loss-prevention would be measured as having less output. Given that both premiums and claims incurred are imperfect measures of insurance output, we follow the suggestion of Cummins and Weis (2000) and alternate between both measures of insurance output.

An estimate of significantly less than 1 for the coefficient of the logarithm of the output variable (β_1) would indicate the presence of unused scale economies. We expect that using claims as output proxy will overstate the potential for scale economies, whereas premiums may understate it, so that using both estimates will give us a range which is likely to include the actual potential for scale economies. In Equation (1) we also add the square of the logarithm of the output variable (in deviation from its average, in Equation (1) indicated by a bar) as an explanatory variable, to discern a possible non-linear relationship with economies of scale varying across the size classes. We use logarithms for output and costs to reduce possible heteroskedasticity.[5]

Further, we include a number of control variables, which may help to explain costs, thereby improving the estimates of the key coefficients for scale economies measurement. The

[5] The estimation approach used also takes care of heteroskedasticity, see Section 5.

ratio of claims incurred and gross premiums may be an indicator of the impact of claims settlement on costs. As more claims may come with higher costs, we expect a positive sign for this control variable. We also include the ratio of reinsurance ceded and gross premiums. As less efficient firms tend to seek reinsurance more often, the coefficient for this ratio is expected to be positive. Moreover, we add the percentage of distribution costs in total costs as explanatory variable, because firms with high relative spending on marketing activities are expected to have higher costs.[6] Another control variable reflects the degree of specialization of non-life insurers in terms of lines of business, presupposing that monolines are most specialized. Specialization is measured by an HHI based on the shares of output associated with the different lines of business within each firm. So, low values for this specialization measure reflect a highly diversified product mix. We expect a negative sign for this control variable, as specialization is likely to reduce total costs. Furthermore, we control for group affiliation as the company structure may also affect the cost level.

An important issue, discussed extensively in the literature, is the effect of the organizational form on performance (*cf.* Cummins, Weiss, and Zi, 1999). A prominent hypothesis in this context is the 'expense preference hypothesis of organizational form', which is derived from agency theory. This hypothesis predicts that mutuals will have higher costs than stocks, because the stock market imposes a more effective mechanism for corporate control and reduces excessive consumption of perquisites by managers and possible deviation from profit maximization principles (Mester, 1989). We examine the effect of organizational form on scale efficiency in two ways. First, we simply add a dummy variable (which is 1 for stock firms) to allow for different cost levels between stock and mutual companies. Second, we run separate regressions for stock and mutual companies to allow for different production technologies.

Finally, a dummy variable is added for each of the lines of business (with miscellaneous insurance acting as the reference group), which takes the value of one if the firm is predominantly in the respective line of business. These lines of business dummies capture any remaining time-invariant (constant) effects related to the respective lines of business. The error term is represented by ε_{it}.

5 Measuring scale economies: empirical results

This section presents estimates of economies of scale in the Dutch non-life insurance industry under the assumption that all firms, both affiliated and unaffiliated, operate independently from

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[6] As this variable may raise endogeneity issues, we estimate the model also without this variable.

each other and, consequently, do not share resources such as common back offices on damage assessment and claim settlement. This is fairly in line with reality where many subsidiary companies operate entirely or highly independently. Further, these firms may focus on different product types, use different distribution channels or operate in different regions. In Section 8, we

Table 3. Estimates of the total costs models on the firm level (1995-2005)

	Full data set				**Stocks**		**Mutuals**	
	Gross premiums		*Claims incurred*		*Gross premiums*		*Gross premiums*	
Output (in logs)	0.89	***	0.72	***	0.92	***	0.86	***
	(0.01)		(0.01)		(0.01)		(0.01)	
Ditto, squared [a]	0.01	***	0.04	***	0.01	**	0.02	***
	(0.00)		(0.00)		(0.00)		(0.00)	
Stock company	0.09	**	0.31	***				
	(0.04)		(0.05)					
Group-affiliation	0.11	***	0.10	***	0.06		0.08	*
	(0.03)		(0.04)		(0.04)		(0.04)	
Specialization (HHI)	-0.20	***	-0.37	***	-0.28	***	-0.12	
	(0.08)		(0.10)		(0.09)		(0.16)	
Claims ratio	-0.03				0.02		-0.15	**
	(0.05)				(0.03)		(0.06)	
Distribution ratio	0.37	***	0.43	***	0.50	***	0.26	***
	(0.06)		(0.09)		(0.08)		(0.09)	
Reinsurance ratio	-0.26	***	0.04		-0.42	***	-0.01	
	(0.07)		(0.08)		(0.10)		(0.07)	
Fire	0.10	*	-0.03		-0.28	***	0.15	**
	(0.05)		(0.06)		(0.08)		(0.07)	
Health	-0.62	***	-0.74	***	-0.42	***	-0.83	***
	(0.05)		(0.07)		(0.06)		(0.08)	
Motor	-0.06	*	-0.09	**	-0.03		-0.20	**
	(0.03)		(0.04)		(0.03)		(0.09)	
Transport	-0.31	***	-0.71	***	-0.58	***	-0.17	**
	(0.08)		(0.10)		(0.15)		(0.08)	
Intercept	-0.35	***	1.61	***	-0.52	***	-0.13	**
	(0.11)		(0.16)		(0.15)		(0.21)	
# of observations [b]	2698		2668		1350		1348	
R^2, adjusted	0.91		0.85		0.92		0.86	

Notes: ***, **, and * denote significantly different from zero at the 99%, 95%, and 90% confidence level, respectively (for output measured as gross premiums or claims incurred: significantly different from 1). The standard errors in round brackets are corrected for heteroskedasticity (HC3-estimator, suggested by Davidson and MacKinnon, 1993). Total costs and output are expressed in the 1995 price level in order to avoid spurious correlation.
[a] Expressed as the deviation (in logs) from average output, allowing for easier interpretation of the coefficients; [b] When claims incurred are used as output measure, the number of observations is lower, as firm-year observation with zero claims are excluded.

drop this premise of independent operations and, alternatively, assume that cooperation between affiliated firms within groups dominates. Table 3 presents estimation results of Equation (1) over the entire 1995-2005 period for, consecutively, the full data set, stock companies and mutual companies.[7] Total costs and output variables are expressed in 1995 prices. To correct for heteroskedasticity, we estimate the standard deviations with the HC3 approach of Davidson and MacKinnon (1993).[8] Irrespective of the output measure employed, Dutch non-life insurance firms enjoy large (and significant) economies of scale.[9] We find that the average degree of scale economies lies between 11% and 28% (see the coefficients of the log-linear output term, β_1), which implies that a 1% increase in size would, on average, increase a non-life insurer's total costs by no more than 0.89% and 0.72%, respectively. The use of gross premiums as an output measure results in lower estimated scale economies, as suggested by Doherty (1981) and Skogh (1982), see above. The stochastic nature of claims incurred pushes the estimate for the output coefficient downwards, in line with the 'errors-in-variable' explanation, with overestimation of scale economies as a result. The true value may lie between these two estimates. The model fit in terms of the adjusted R^2 is quite good, but the variation in total costs is explained much better by premiums as output measure (91%) than by claims (85%). In an alternative model variant using both proxies of output simultaneously (not shown here), almost all explanation stems from premiums, whereas claims play a only very minor role. Apparently, premiums are better output proxies than claims, which we attribute to the stochastic nature of claims. Although in the remainder of this paper we continue to measure output by both premiums and claims (to overcome the theoretical objections against these proxies), we focus mainly on the premium results which we consider as more reliable.

The quadratic output terms have significantly positive coefficients, which make clear that the economies of scale for non-life insurers are not constant, but decrease with increasing firm size. This empirical relationship between economies of scale and firm size is depicted in Figure 2 for premiums as output measure. When cost elasticity of output becomes equal to 1, we see constant returns to scale. At this point, reflecting a premium income of €390 million (in 1995 prices), the firm size reaches its optimal scale. Larger non-life insurance firms face scale diseconomies.[10] Note, however, that according to the confidence interval in Figure 2 scale diseconomies for these firms may well be zero. The sample distribution of premium income (also

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[7] Multicollinearity does not seem to be a problem here. Correlations between the independent variables do not exceed (in absolute value terms) 0.50.

[8] This approach is superior to White's HC0-estimator. Long and Ervin (2000) evaluate the power functions of the *t* tests of the regression coefficients, using both the ordinary OLS estimator and the HC methods. , They state that HC3 is preferable to its predecessors under all circumstances, as it keeps the test size at the nominal level regardless of the presence or absence of heteroskedasticity. Moreover, there is only a slight loss of power associated with HC3, when the errors are in fact homoscedastic. Cribari-Neto, Ferrari, and Oliveira (2005) confirm the superiority of HC3 using simulations results.

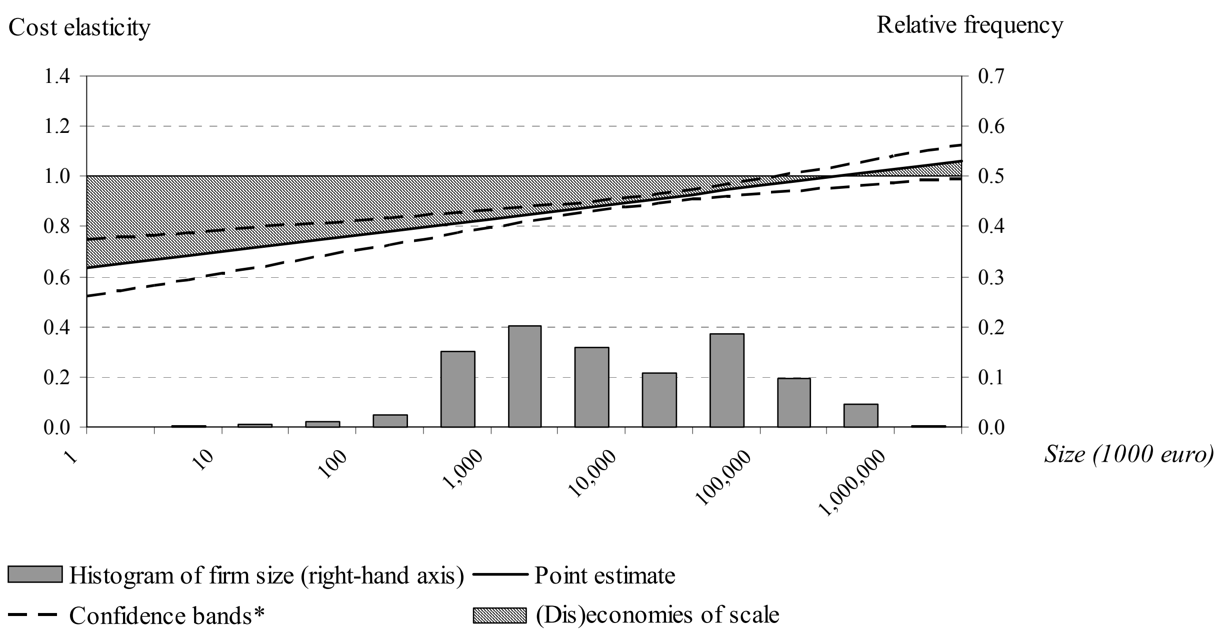
[9] Similarly, Bikker and Van Leuvensteijn (2008) find large economies of scale in the Dutch life insurance industry.

[10] Bikker and Bos (2008) observe also an optimal size for banks with diseconomies of scale for the largest banks.

included in Figure 2) shows that the majority of firms is below the optimal scale, even allowing for the uncertainty surrounding cost elasticity estimates. Indeed, with a probability of 95% we conclude that 88% of firms face unused economies of scale. Our results are in line with earlier non-life insurance studies, which generally report economies of scale for small and medium size firms and diseconomies of scale for large firms.[11]

Irrespective of our choice of output measure, we find that mutual insurers have significantly lower costs. Similar results, which contradict the expense preference theory, have been found by Cummins *et al.* (1999) and Fecher *et al.* (1993). Very likely mutuals profit from their less complex organizations. The regression results in the last two columns of Table 3 show that mutual companies experience significantly larger economies of scale than stock companies. Probably mutual companies experience less pressure to exploit unused economies of scale.

Figure 2. Cost elasticity of output (measured as premiums) and insurance firm size



Note: The actual size of Dutch non-life insurers ranges from € 1,000 to € 1.5 billion premium income (in 1995 prices). Shading below $y=1$ and above the cost elasticity curve reflects economies of scale, while shading above $y=1$ and below the cost elasticity curve points to diseconomies of scale.
* Confidence bands are based on plus and minus twice the standard deviation.

Moreover, as the coefficient for group affiliation is positive across all (sub)samples, and highly significant for the full dataset, we conclude that affiliated firms have, on average, higher costs. A possible explanation is that insurance groups have additional overhead costs, which are spread out

[11] See references to other studies in the introduction.

over their affiliated firms. Conversely, specialized firms have significantly lower costs. This result supports the strategic focus hypothesis, which states that bundling different lines of business is likely to destroy firm value, as combining increases management and coordination costs. Firms that spend relatively more on acquiring business and distribution activities have significantly higher costs (probably raising also additional revenues), in line with expectations.[12] Firms that have relatively more claims to settle do not have significantly higher costs. Reinsurance appears to lower total costs significantly in two out of three models where output is measured by premiums. Health and transport insurance firms tend to have lower average costs. In these lines of business a substantial proportion of policies written carry sizeable premiums, leading to lower cost margins.

All in all, we find plausible and highly significant coefficients for most explanatory variables of our operating and acquisition costs model. Moreover, we observe quite similar estimates for scale economies across various samples used (full sample, stock companies, and mutuals), so that the results appear fairly robust.

6 Economies of scale over time

Scale economies may change over time instead of remaining constant. For instance, scale economies may fall off gradually due to increased competition and pressure from shareholders. We investigate possible changes in economy of scale estimates by re-estimating Equation (1) for three subperiods, namely 1995-1997, 1998-2001 and 2002-2005.[13] Table 4 presents the estimation results.

Our estimates appear quite robust over time: in all periods we observe strong scale economies, similar to earlier estimates and irrespective of the chosen output measure. Although the market underwent strong consolidation during the sample period (see average actual firm sizes over time), unused scale economies actually increased instead of diminishing. This can be explained by the observed phenomenon that the optimal firm size has increased significantly over time, especially over the last few years. This probably reflects the rise in optimal IT investments and the increasing costs of legal, supervisory and accounting requirements, which are likely to increase less than proportionally with size. Apparently, consolidation has not been rapid enough

[12] If we drop the distribution ratio as explanatory variable, the results do not change much: scale economies are estimated (based on premiums as output measure) at 10% (instead of 11%) and all coefficients keep their signs shown in Table 3.

[13] Separate regressions for each year would result in less reliable estimates of optimal size. For this reason we run the regressions for sub periods shown in Table 4, representing each about three to four years.

to catch up with the required increase in scale. Evidently, competitive pressure has not been heavy enough to squeeze out the growing unused scale economies. Almost all firms continuously operate below their optimal size, suggesting that further consolidation would have lowered their operating and acquisition costs, relative to their premiums and incurred claims. The largest five firms, however, experience structural diseconomies of scale, which suggests that for these firms consolidation may have taken place too early (or suboptimally).

Table 4. Estimates of economies of scale over time (1995-2005)

Output measure	Period	# obs	Scale economies (%)	Size (in millions of euro, in 1995 prices)				
				Optimal	*Actual*			
					Average	P_{10} [a]	P_{90}	Largest 5 [b]
Premiums	95-97	805	10	213	47	0.6	109	739
	98-01	1015	9	243	55	0.6	155	961
	02-05	878	13	742	81	0.7	240	1,317
	95-05	*2698*	*11*	*390*	*61*	*0.6*	*163*	1,317
Claims	95-97	800	24	112	31	0.2	80	438
	98-01	1001	29	156	38	0.2	113	653
	02-05	867	31	255	53	0.3	162	1,048
	95-05	*2668*	*28*	*182*	*40*	*0.2*	*111*	1,048

[a] P_{10} and P_{90} stand respectively for the 10th and 90th percentile; [b] Average size.

7 The strategic focus of insurance firms

One characteristic of the restructuring of the non-life insurance industry has been firms' increasing focus, that is, the tendency to combine fewer lines of business within one firm. In order to investigate whether such policies may have been partly driven by scale economies or other efficiency arguments, we re-estimate Equation (1) separately for monoline and multiline insurers. The results in Table 5 reveal that monoline insurers face, on average, greater economies of scale than multilines, namely (based on premiums as output measure) 16% versus 5%. This outcome supports the observed focus on specialization in the sense that unused economies of scale appear to be largest in the monolines. The results with claims incurred used as output measure are similar but, again as observed above, very probably overestimate the economies of scale due to their stochastic nature. As the estimates in Table 5 show, this problem is smaller for multilines, where claims incurred are aggregated across the respective lines of business, thereby reducing their variation.

Although monoline insurers benefit from specialization in terms of lower cost margins (given firm size, see Section 5), we find here that for multiline insurers the optimal firm size is larger. In fact, for multiliners scale economies do not seem to decrease at all (see the coefficients for the quadratic output terms). As these firms combine a number of monolines, the amalgamation of the underlying monoline cost elasticity curves has been flattened out. The coefficients of the control variables are all in line with what we observed in Section 5, except for reinsurance, whose coefficient differs across the model variants. [14]

Table 5. Scale economies of monoline and multiline insurers

	Monoline insurers		**Multiline insurers**	
	Gross premiums	*Claims incurred*	*Gross premiums*	*Claims incurred*
Output (in logs)	0.84 ***	0.64 ***	0.95 ***	0.88 ***
	(0.01)	(0.01)	(0.01)	(0.01)
Ditto, squared [a]	0.03 ***	0.05 ***	0.00 *	0.01
	(0.00)	(0.00)	(0.00)	(0.01)
Stock company	0.19 ***	0.36 ***	-0.04	0.20 ***
	(0.05)	(0.05)	(0.06)	(0.07)
Group-affiliation	-0.00	0.04	0.26 ***	0.18 ***
	(0.04)	(0.04)	(0.04)	(0.05)
Claims ratio	0.01		0.01	
	(0.10)		(0.02)	
Distribution ratio	0.44 ***	0.63 ***	0.43 ***	0.48 ***
	(0.10)	(0.12)	(0.07)	(0.11)
Reinsurance ratio	-0.10	0.25 **	-0.40 ***	-0.20
	(0.10)	(0.10)	(0.09)	(0.12)
Fire	0.29 ***	0.02	-0.22 ***	-0.17 **
	(0.06)	(0.07)	(0.07)	(0.09)
Health	-0.59 ***	-0.81 ***	-0.03	0.33 **
	(0.07)	(0.08)	(0.05)	(0.15)
Transport	-0.06	-0.42 ***	-0.71 ***	-1.22 ***
	(0.07)	(0.09)	(0.15)	(0.21)
Intercept	-0.28 **	1.80 ***	-0.98 ***	-0.00
	(0.12)	(0.11)	(0.12)	(0.16)
# of observations [b]	1704	1684	994	984
R^2, adjusted	0.86	0.78	0.95	0.89

Notes: ***, **, and * denote significantly different from zero at the 99%, 95%, and 90% confidence level, respectively (for output measured as gross premiums or claims incurred: significantly different from 1). The standard errors in round brackets are corrected for heteroskedasticity (HC3-estimator, suggested by Davidson and MacKinnon, 1993). Total costs and output are expressed in the 1995 price level in order to avoid spurious correlation. Dummy variable for motor insurance has been dropped, as none of the monolines is active in this line of business.
[a] Expressed as the deviation (in logs) from average output allowing for easier interpretation of the coefficients; [b] When claims incurred are used as output measure, the number of observations is lower, as firm-year observation with zero claims are excluded.

[14] Again, dropping the distribution ratio does not materially change our results. Scale economies for monolines and multilines are then estimated (based on premiums as output measure) at respectively 15% and 4%, instead of 16% and 5%.

8 Scale economies on different aggregation levels

Earlier estimates of economies of scale were based on the assumption that like unaffiliated firms, affiliated companies operate independently from each other and, consequently, do not share resources. Although many subsidiary companies do indeed operate entirely or highly independently, this does not hold true for all affiliated firms. In a number of groups, the subsidiaries share resources or undergo a process of collaboration, anticipating full integration.[15] For this reason we also consider the opposite assumption of full coordination among affiliated firms within groups, by measuring economies of scale at the group level. To enable comparison, Table 6 also shows estimates of the same model applied to the firm level and the lines of business level.[16]

Table 6. Estimates of the total costs model on three aggregation levels

	Groups				**Firms**				**Lines of business**			
Output measures	*Premiums*		*Claims*		*Premiums*		*Claims*		*Premiums*		*Claims*	
Output (in logs)	0.90	***	0.77	***	0.87	***	0.73	***	0.92	***	0.80	***
	(0.01)		(0.01)		(0.01)		(0.01)		(0.00)		(0.01)	
Ditto, squared [a]	0.02	***	0.05	***	0.02	***	0.04	***	-0.01	***	0.00	
	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Claims ratio	-0.11				-0.10				-0.04	**		
	(0.07)				(0.08)				(0.02)			
Acquisition ratio	0.86	***	1.20	***	0.72	***	1.02	***	0.52	***	0.54	***
	(0.07)		(0.11)		(0.05)		(0.08)		(0.03)		(0.05)	
Reinsurance ratio	-0.09		0.24	**	0.18	**	0.52	***	-0.22	***	0.00	
	(0.09)		(0.11)		(0.07)		(0.09)		(0.05)		(0.06)	
Intercept	-0.88	***	0.45	***	-0.60	***	0.87	***	-0.76	***	0.73	***
	(0.09)		(0.12)		(0.08)		(0.09)		(0.05)		(0.06)	
# of observations [b]	1438		1420		2698		2668		5346		5270	
R^2, adjusted	0.92		0.85		0.89		0.82		0.91		0.81	

Notes: ***, **, and * denote significantly different from zero at the 99%, 95%, and 90% confidence level, respectively (for output measure gross premiums or claims incurred: significantly different from 1). The standard errors in round brackets are corrected for heteroskedasticity (HC3-estimator, suggested by Davidson and MacKinnon, 1993). Total costs and output are expressed in the 1995 price level in order to avoid spurious correlation.
[a] Expressed as the deviation (in logs) from average output, allowing for easier interpretation of the coefficients. [b] When claims incurred are used as output measure, the number of observations is lower, as firm-year observation with zero claims are excluded.

The average scale economies appear to follow a reversed U-shaped curve across the levels of aggregation based on premium as output measure, being smaller for groups (10%), larger for

[15] In the foregoing (*e.g.* Table 1) only group holdings, with two or more affiliated firms, were regarded as groups. In this section, groups are defined as the independent insurance companies, including both group holdings and unaffiliated firms.
[16] Our earlier model deviates from this model. For instance, the costs model of firms in Table 5 includes lines-of-business dummies. Of course, such dummies are not possible in a costs model of lines of business.

firms (13%) and again smaller for lines of business (8%). For lines of business, scale economies are based mainly on volumes: average costs fall with increasing sizes. At the firm level, volumes remain essential for scale economies, but elements of focus or scope become also important: combining lines of business might be profitable if sources, such as advertising, distribution and back offices, can be joined together. Apparently this effect is stronger than the possible loss of specialization or focus, so that scale economies are highest for firms. Note that we assume here that, on average, a larger scale also picks up some scope economies. At the group level, the impact of volumes on scale economies dominates, but assembling firms also implies an increase in the complexity of the organization. Consequently, scale economies are smaller on the group level than on the firm level.

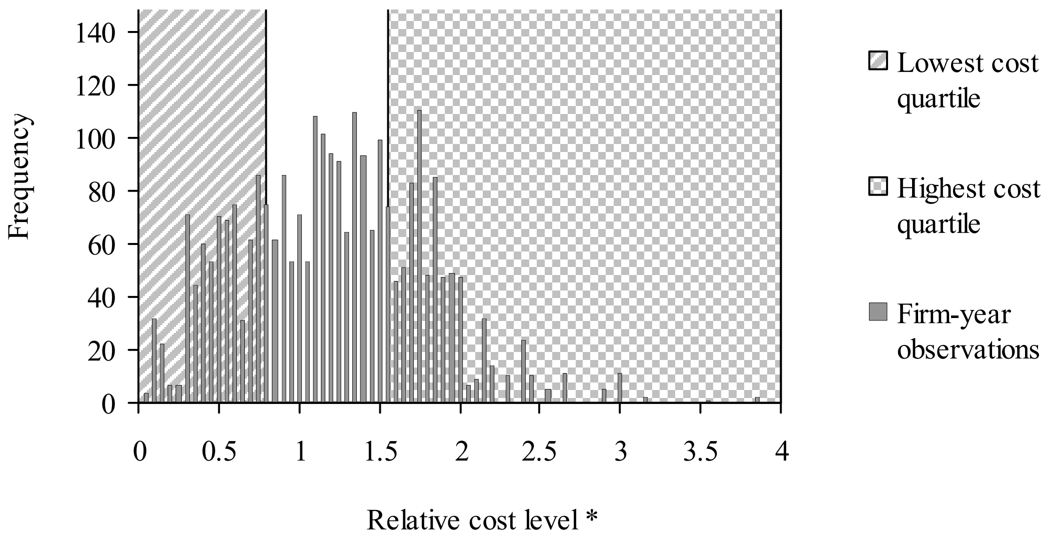
The coefficients of the control variables are in line with what we observed in previous sections, where reinsurance varies again across the considered total cost models and remains difficult to interpret.

9 Cost X-inefficiencies

This section evaluates the cost inefficiency of the Dutch non-life insurance market, by examining X-inefficiencies based on differences in cost levels among Dutch non-life insurance firms. We build on previous analyses by using Equation (1) and, hence, controlling for firm size, product mix and other firm characteristics. Cost differences between insurance firms can be interpreted as *firm inefficiencies*, due to firm-specific conditions. In principle, managerial (in)ability and firm-specific conditions can reflect mutually independent aspects of (in)efficiency. In practice, cost differences may overlap in part with firm-specific X-inefficiencies (as measured by the stochastic cost frontier approach), where differences in firm conditions affect the measurement of X-efficiencies (that is, where unfavourable conditions are mistaken for X-inefficiency) or where differences in managerial abilities exist between insurance firms (and get mixed up with cost differences). Differences in cost levels across insurance firms are measured by adding a dummy to the cost equation for each insurance firm (*cf.* Bikker, 2002).

Figure 3 presents insurance firms' estimated cost levels, relative to the geometric mean. Two findings stand out. First, the cost distribution of the Dutch non-life insurance industry is widely dispersed, probably due to the heterogeneous character of the market. As mentioned, the Dutch market knows many niche segments, possibly sheltered from head-on competition. Second, several observations seem to qualify as outliers. Given these observations, we use a so-called 'thick frontier' method to produce an X-inefficiency measure for the whole sample. More specifically, we compare the median cost level of insurers in the lowest and highest cost quartiles and assume that the lowest cost quartile represents the thick frontier.[17] The principal advantage of this approach over other approaches that estimate a precise frontier *edge*, is that the influence of outliers is excluded.[18]

Figure 3. Differences in cost levels across non-life insurance firms



* By construction, the geometric mean of the relative cost levels is equal to 1.

Nonetheless, thick frontier analysis also has its drawbacks. First, it assumes that cost differences within the highest and lowest cost quartiles only reflect random errors, and second, it does not permit estimating individual insurer (in)efficiency. Fortunately, however, these general shortcomings do not prevent us from getting a basic idea of the likely magnitude of inefficiencies in the Dutch non-life insurance industry, which is our goal here.

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[17] Note that our thick-frontier approach differs in two respects from that of Berger and Humphrey (1991). First, our method does not compare unit costs, *i.e.* total costs divided by total output, of efficient and inefficient firms but compares relative cost levels, given various firm characteristics (such as, for example, output). Consequently our approach does not require an estimate of the *level* of total costs, whereas the standard thick frontier approach does. This is a great boon, because estimation of expected total costs from a log-normal cost model is highly troublesome. Indeed, one cannot simply reverse the logarithmic transformation to obtain expected total costs. An often-used method to retransform the total cost variable back to its nominal level is the so-called smearing estimate (Duan, 1983). However, this approach is only valid in the unlikely case that the assumption of homoskedasticity holds. When the error term is heteroskedastic, retransformation is less straightforward (see, *e.g.*, Manning and Mullahy, 2001). Our alternative approach does not suffer from retransformation problems, as the error term is most likely fairly homoskedastic (thanks to the firm-specific dummies) and the focus is on relative instead of absolute costs, so smearing is unnecessary. Second, under our approach the cost model, *i.e.* Equation (1), is estimated for the entire sample, whereas under the standard thick frontier approach separate cost functions are estimated for the lowest and highest cost quartiles.

[18] By contrast, the stochastic cost frontier approach, which has been widely applied, is very sensitive to outliers related to *e.g.* niche market insurance firms.

According to the cost distribution shown, costs are 191% higher for the cost-inefficient firms than for the best practice firms, conditional on production scale and other firm characteristics, as far as considered. While this substantial percentage should be treated with due care, as cost differences may also reflect different products, niche markets, etc., it points to sizeable inefficiencies of Dutch non-life insurers of 74%. This is also high in comparison with what has been found in non-life insurance studies of other countries.[19] Consequently, the outcome tends to refute the hypothesis that the Dutch market is fully efficient and characterized by heavy competition.

If we repeat this thick frontier analysis for each of the five lines of business separately, using the model from the previous section, we obtain the lines-of-business specific cost distributions and thick frontier inefficiencies (see Table 7 and Figures 4-8 in the appendix). The estimates for health and other insurances may point to lower efficiency in these lines of business, whereas motor insurance and transport insurances seem to be relatively efficient. Of course, inefficiency of the entire sector is on average higher as all kind of lines of business and combinations thereof are included.

Table 7. Inefficiencies of lines of business

Lines of business	Median cost level lowest cost quartile	Median cost level highest cost quartile	Thick frontier inefficiency (%)
Fire insurance	0.57	1.74	67
Health insurance	0.50	1.95	74
Motor insurance	0.68	1.60	58
Other insurances	0.43	1.68	74
Transport insurance	0.72	1.55	54
Entire non-life insurance sector	*0.47*	*1.83*	*74*

Note: By construction, the geometric mean of the relative cost levels is equal to 1.

10 Conclusions

The deregulation of Europe's insurance markets since the last decade has fostered cross border competition, raising the expectation that competition and, hence, efficiency in the EU Member States has improved over time. This paper investigates competition in the Netherlands indirectly, by measuring scale economies and X-inefficiency, on the assumption that strong competition would force insurance firms to exploit unused scale economies and to push down inefficiencies. Indeed, we observe that the non-life insurance sector underwent considerable consolidation during the last decade. We also note that apart from scaling up, insurance firms tend to focus

[19] See cited references in the introduction.

more, that is, to reduce the number of lines of business per company. Focus also helps to push down costs.

We investigate the non-life insurance market by measuring scale economies and thick frontier inefficiencies. We find that scale economies of firms are substantial at above 10% on average, depending on the measure of output, and the type of firm. Scale economies appear to be subject to firm size: they are larger for smaller firms and *vice versa*, in fact turning to diseconomies for the largest firms. Specialization significantly lowers the sum of operating and acquisition costs, confirming that focusing on one or on a few lines of business instead off all lines of business is rewarding. Monoline insurers face, on average, greater economies of scale than multilines. This outcome supports the observed strategic choice in favor of specialization, in the sense that the largest unused economies of scale exist in the monolines. Comparing mutual and stock companies, we find that the former experience, on average, greater economies of scale. Probably mutual insurers encounter less competitive pressure to reduce scale inefficiencies.

Estimated economies of scale have increased over the last decade, despite considerable consolidation. The reason is that the optimal scale expands at a faster pace than the actual one. This could point to a worsening lack of competitive pressure over time.

Insurance groups are made up of affiliated firms, whereas the latter may each pursue a number of lines of business. The question arises which is the best level of aggregation to estimate scale economies. When we compare estimates across aggregation levels, we observe a reversed U-shaped curve: scale economies are smaller for groups (10%), larger for firms (13%) and smaller again for lines of business (8%). Scale economies for lines of business are based mainly on volume: average costs fall with increasing size. On the firm level, volume remains essential for scale economies, but here focus or scope comes in as well: combining lines of business may be profitable if sources can be joined, *e.g.* advertising, distribution channels and back offices. Apparently this effect is stronger than the possible loss of specialization or focus, so that, on this firm level, scale economies are highest. On the group level, the impact of volumes on scale economies dominates, but assembling heterogeneous firms increases the complexity of the organization, resulting in lower scale economies than on the firm level.

Finally, we estimate thick frontier efficiency. Large cost differences across firms as well as across lines of business emerge, pointing to wide diversity across firms in terms of business. However, they also suggest that actual competitive pressure may be insufficient to align average costs.

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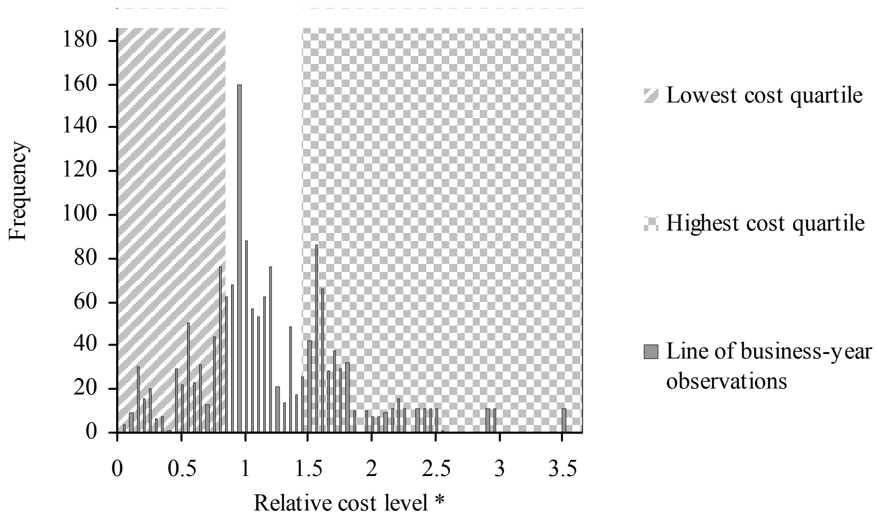
APPENDIX DIFFERENCES IN COST LEVELS ACROSS LINES OF BUSINESS

Figure 4. Differences in cost levels across fire insurers



* By construction, the geometric mean of the relative cost levels in Figures 4-8 are equal to

Figure 5. Differences in cost levels across health insurers

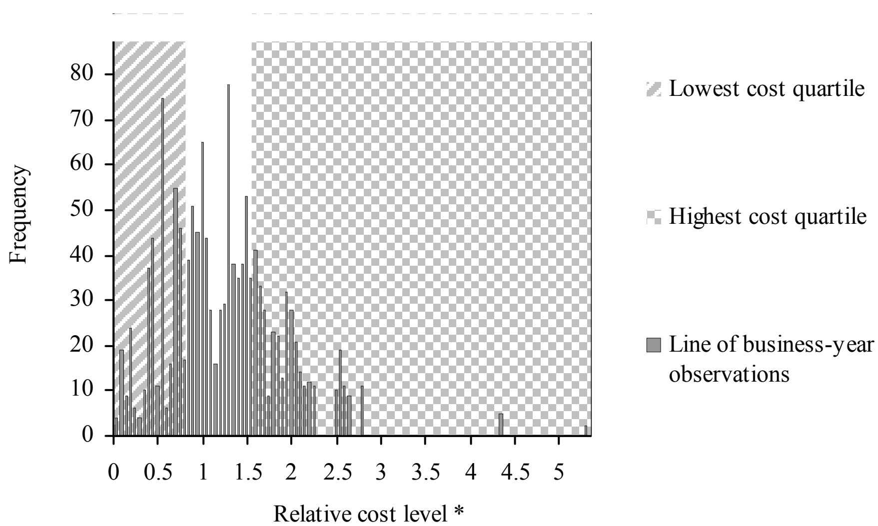


Figure 6. Differences in cost levels across motor insurers

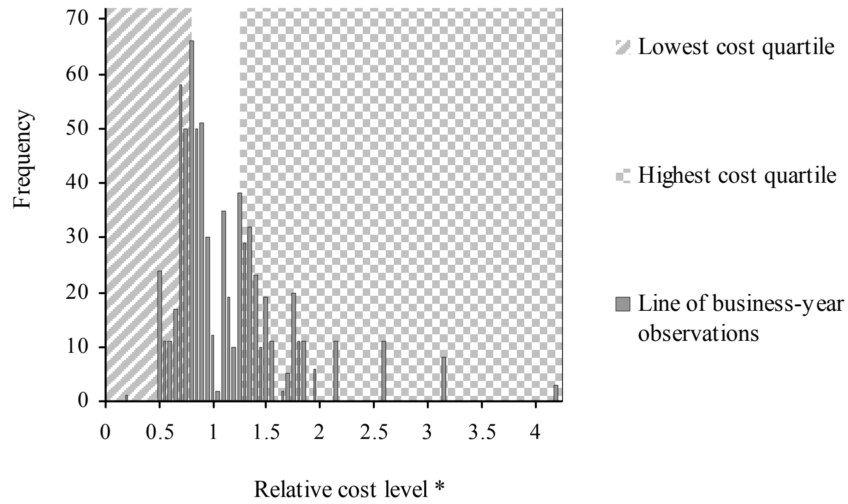


Figure 7. Differences in cost levels across 'other' insurers

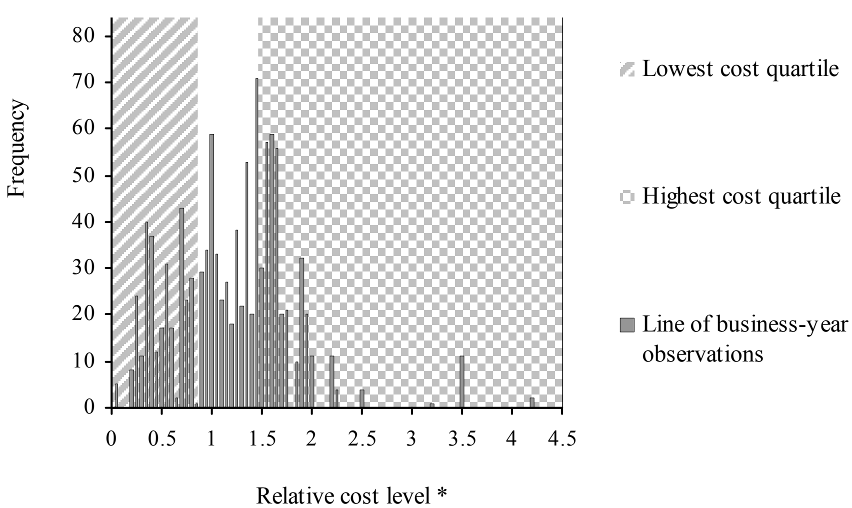


Figure 8. Differences in cost levels across transport insurers