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Economies of scale and scope in the Finnish non-life insurance industry

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Abstract

Economies of scale and scope in Finnish non-life insurance are studied. The production process is separated into cost and portfolio management functions. Firms expand their branch network to either gain market power or informational advantages. There are diseconomies of scale at firm and economies of scale at branch level, and economies of scope in production. Large firms in the non-life insurance industry pay a substantial premium to gain market power via branch networks. The retained premiums-curve of portfolio management is U-shaped and a positive function of the number of branches. © 1997 Elsevier Science B.V.

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1. Introduction

There are relatively few published studies on the cost efficiency of the insurance industry (see Skogh, 1982, Cho, 1988, Suret, 1991, Fecher et al., 1992, Cummins and Weiss, 1993 and Yuengert, 1993). These studies typically find economies of scale up to about $15 billion in assets, constant or decreasing returns thereafter, and small or non-existent scope economies. The present study seeks to contribute to this literature by reporting empirical evidence from the Finnish

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non-life insurance industry. More specifically, we explore economies of scale, scope and efficiency and the role of branches.

An important issue in financial services is how to distribute the services. In retail banking and insurance, the most common choice is a branch network. Opening a branch not only affects the cost structure of the firm but can also create local market power in an oligopolistic environment (see Tirole, 1988). A profit-maximizing firm thus will not necessarily minimize firm level costs, as assumed in neoclassical production theory. Another possible effect is economies of scope – if a larger branch network allows the firm to produce a wider variety of products, production costs per product could be decreased [1].

The cost structure of insurance firms can be divided into operating costs of the firms on the production side and the costs of incurred claims on the portfolio management side. Apart from profit function studies such as Berger et al. (1993) and Akhavein et al. (1994), studies on the cost structure of financial services tend to neglect the portfolio management side although usually claims (interest payments for banks) constitute a far higher proportion of total costs than actual operating costs. The approach in profit function studies, however, assumes perfect competition and would hence be difficult to accept for a market as highly concentrated as the Finnish non-life insurance market. In this paper, economies of scale and scope and the degree of (in)efficiency in production are compared to the degree of economies of scale and scope in portfolio management in Finnish non-life insurance companies. Other results provide an explanation for the "scale efficiency" puzzle of first increasing and then decreasing economies of scale (see McAllister and McManus, 1993).

The next Section 2 describes the Finnish non-life insurance market and the data. Section 3 provides theoretical motives for branch proliferation, the research hypotheses, and the empirical specification. The empirical results are presented in Section 4. Finally, Section 5 gives conclusions.

2. The finnish non-life insurance market

The data used in this study is from the Finnish non-life insurance market. This market provides an interesting laboratory for several reasons. All the firms relied on branches for distribution, as there were (almost) no brokers during the observation period 1989–1991 [2]. Thus, it can be assumed that all firms rely on the

[1] There exist studies on branch level economies of scale and scope in banking (e.g. see Zardkoohi and Kolari, 1994) that use branch level data.

[2] The time period was chosen to be 1989–1991 because (a) the branch data available was from 1989, (b) a short panel was preferred to avoid effects from technological change shifting the (frontier) cost function, and (c) we wanted to avoid the effects of the severe economic recession Finland entered in 1992. Three years of data was deemed to be enough to provide adequate degrees of freedom.

same (or at least, closely related) technology. There were considerable differences in the size of branch networks. The number of products, as listed in *Statistics Finland: Insurance* [3], is large – 38 product lines can be found for which both quantity and price (premium income) data is available. The large geographical size (over 300 000 sq. km.) relative to population (5 million) suggests that a branch network is an effective means to increase market power in Finland.

The different lines of insurance are listed in Table 1 [4]. Statutory accident and motor third party liability insurance are regulated and compulsory. There is both price regulation (which was gradually relaxed during the observation period but not abolished) and entry regulation. The regulation of these lines likely strengthens the oligopolistic captivation effect in that firms engage in quality competition when price competition is banned or restricted.

The structure of the market has been relatively stable until recently. Major changes have occurred since the deep recession of the Finnish economy in 1994. To avoid capturing the market at a potential disequilibrium stage, we decided to use data from the 1989–1991 period when theThese lines can be viewed as part of the international market, where market power of Finnish firms is bound to be lowmarket was still stable. As a brief overview, the Finnish non-life insurance market can be described as follows: number of firms = 21; highest number of branches = 107; lowest number of branches = 1; mean number of branches = 22; number of firms with one branch = 10 and average number of products = 21.

3. Theory and empirical methodology

3.1. Branch proliferation motives in insurance and research hypotheses

The standard Hotelling model of product differentiation (see Tirole, 1988) and its variants can be given a geographical interpretation. Opening a branch has two effects: (1) the firm has to incur a fixed cost, and (2) its market power increases through horizontal product differentiation. The former of these is the *cost effect* – that is, as long as there are some fixed costs in establishing a branch, and there are no extreme diseconomies of scale, the firm's average costs could increase. The latter is the *captivation effect*. This trade off is counter to the standard theory underlying cost function estimations which usually assumes (perfect) competition

[3] Most data is from *Statistics Finland: Insurance*. The number of branches per firm was kindly collected by the research department of the Association of Finnish Insurers. The Insurance Dept. of the Ministry for Health and Social Affairs, which is the regulator of the industry, provided data on the so-called smoothing reserve, which was needed in calculating the portfolio returns. The help is thankfully acknowledged.

[4] During the observation period, 1 FIM (Finnish Markka) was approximately 1/4 U.S. dollar and 1/8 British pound.

Table 1
Lines of insurance in the Finnish non-life insurance market (1991) [a]

General category/subcategory	No. of firms	Premium income (1000 FIM)	% of total	CR4
Statutory accident ins.				
general tariffs [b]	13	876623	7.8	83.9
special tariffs [b]	13	1156707	10.3	88.1
ins. against other accidents	13	60958	0.5	83.1
Other accident ins.				
continuous individual	14	338930	3.0	68.4
cont. group ins.	13	108581	0.9	91.2
traveller's ins. etc.	15	186424	1.7	92.9
other ins.	12	13387	0.0	87.6
Compulsory motor third party liability ins.	13	2481157	22.1	73.1
Motor vehicle ins.	16	1676160	14.9	80.0
Hull ins.				
ship hull, civil	9	141645	1.3	89.8
ship hull, war	5	6995	0.1	99.6
protection and indemnity liability	1	1521	0.0	100.0
yacht ins.	14	71931	0.6	75.5
aircraft hull ins.	8	9177	0.1	97.9
aviation liability	6	4034	0.0	99.5
Cargo ins. [c]	18	339271	3.0	84.4
Fire and other combined property ins.				
households' fire ins.	13	57071	0.1	63.3
households' compr. house etc. ins.	15	1155460	10.3	76.2
farm ins.	13	174619	1.6	84.5
other ins.	4	165	0.0	100.0
industrial fire	15	287783	2.6	86.8
trading fire	12	26636	0.0	91.9
other fire ins.	11	69689	0.1	93.4
real estate ins.	17	421673	3.8	81.5
combined ins. (industrial)	11	188278	1.7	70.8
combined ins. (trade)	12	111411	1.0	93.3
combined ins. (other)	10	107281	1.0	89.1
burglary and robbery ins.	12	24163	0.2	91.2
water damage ins.	11	8989	0.0	95.1
glass and shield ins.	10	3830	0.0	88.5
machinery breakdown ins.	9	64175	0.6	82.2
other ins.	5	16562	0.1	100.0
Loss of profit ins.	7	175832	1.6	96.0
Forest ins.	13	32360	0.3	85.8
Third party ins.	18	327049	2.9	84.1
Credit ins.	18	317577	2.8	71.0
Other ins.	19	160231	1.4	92.9
Finnish reins. [d]	32	932880		
Foreign ins. [d]	13	1611887		

and thus cost minimisation is equal to profit maximisation (see Jorgenson, 1986 and the references cited therein). In line with standard theory, it has usually been assumed that firms only open new branches to exhaust the economies of scale that the production technology offers. The costs of branch proliferation (the cost effect) show up in the production technology side, and the benefits (the captivation effect) on the portfolio management side.

On the portfolio side, it is also possible that a financial services firm with a large branch network is able to get better information on its clients than a rival with a small branch network. It has been shown (Toivanen, 1995) that even in a situation where the only benefit from a branch network is that the firm can distinguish different types of customers from each other, a firm with a branch network will be able to sustain higher prices (taking the type of customers as given) than its (direct-selling) rival. If insurance firms use their branches as information gathering devices, this leads to both lower claims and lower premiums and higher profits per contract. Hence it is important to examine both premiums and claims.

A third possible motive for branch proliferation is that customers have imperfect information on the type of the firm. They might not know for sure what the claims policy of a firm is (i.e., whether the firm is lenient or strict in paying claims). A large branch network is a sunk cost and can thus act as a commitment to cover its costs. Thus, a firm with a large branch network has to attract many customers and be more lenient.

Two related research hypotheses are:

H_1: *If the firms in Finnish non-life insurance are engaged in oligopolistic competition that involve branch proliferation as a strategic tool, the number of branches can deviate from the cost minimizing one.*

H_2: *If there are diseconomies of scale on the firm level and specifically, in opening branches, a positive captivation effect should exist (i.e., firms' profits gross of operating costs should increase as a function of the number of branches).*

The null hypothesis against which H_1 is tested is that the number of branches does not deviate from the cost-minimizing solution. H_2 is tested against the null hypothesis of branches not affecting the firms' profits gross of operating costs (i.e., no captivation effect).

Notes to Table 1:

[a] No. of firms = no. of firms which actually sold policies in 1991, as opposed to being listed as (potentially) providing them; % of total = % of total direct domestic premium income (thus not provided for the two last categories); CR4 = combined market share of 4 largest firms (based on the output measure used, usually the no. of contracts).

[b] Measure of output is working time in millions of working hours.

[c] Measure of output is no. of accidents.

[d] Measure of output is premium income.

One of the technical developments of recent years in cost- and production-function literature are frontier estimations (see Bauer, 1990, and Seiford and Thrall, 1990). Here the researcher relaxes the assumption that all firms use inputs efficiently. Theory suggests that (traditional) functional forms that do not include the number of branches as an explanatory variable may lead to systematically upward biased estimates of inefficiency because these do not take into account the captivation effect which can make it optimal even for a efficient firm to deviate from the cost-minimizing solution. The extra costs (that do not vary with other output) incurred in opening branches are (partly) interpreted as inefficiency. The correct specification allows the researcher to separate these effects into costs of branch proliferation and inefficiency. Thus, traditional functional forms give a measure of inefficiency that is biased upwards, and this bias is positively related to the number of branches. As such, our third research hypothesis is:

H_3: *If there are diseconomies of scale in branch proliferation, the difference between measured inefficiency between the preferred model and both traditional models (see Eq.* 2 *Eq.* 2a *Eq.* 2b) *is an increasing function of the number of branches.*

3.2. Empirical methodology

Currently the standard tool of cost function analysis is the translog cost function (see Christensen et al., 1973). However, because it does not allow for zero production of any product, it cannot be used and a quadratic specification will be used instead:

$$C = \alpha + \beta_i x_i + \Sigma \gamma_{ii} x_i^2 + \sum_{i \neq j} \gamma_{ij} x_i x_j \tag{1}$$

where x_i = output of product i. The quadratic cost function has two drawbacks. First, it cannot be deduced theoretically. This is a minor problem, since any cost function should be viewed as a statistical (or theoretical) approximation to the true, underlying cost function. Second, it does not allow an easy incorporation of inputs[5]; however, with the particular data set used, this is not a major problem. Labour accounts for a major share (on average 56%) of operating costs, and wages are centrally negotiated at the industry level. They can thus be assumed to be constant across firms. The standard way of treating a cost function has been to estimate Eq. (1) directly (Daly et al., 1985 and Lawrence, 1989). Some studies have included a branch variable to ''control for the number of branches'' (Murray and White, 1983). This has usually been done simply by adding a linear branch-variable into Eq. (1), although some studies (Kolari and Zardkoohi, 1990) have treated the branch variable like any other input or output variable.

[5] See Röller (1990) for a methodology to incorporate input prices into a quadratic cost function.

The main problem empirically in this study is the large number of products. A fully specified cost function would have 820 parameters. With the current data set, this would necessitate at least 40 years of data to cover the parameters. The cost function is thus constrained in two steps:

(1) all outputs are converted into money terms using the per policy premium of the largest firm as price, to avoid the systematic bias in prices suggested by locational models of product differentiation; and

(2) the linear, quadratic and crossproduct terms are each assumed to have the same coefficients.

Based on these constraints the model becomes:

$$C = \alpha + \beta \Sigma p_i x_i + \psi k + \gamma \Sigma (p_i x_i)^2 + \rho k^2 + \delta \Sigma\Sigma p_i p_j x_i x_j + v \Sigma p_i x_i k, \quad i \neq j \tag{2}$$

where k = no. of branches, and the number of parameters has been reduced from 820 to 7. The effect of constraining all the linear, quadratic and crossproduct terms to the same coefficients is equal to assuming that the marginal costs for producing any line of insurance are identical. Although probably not true in practice, this assumption allows us to proceed with the estimation by reducing the number of parameters to a level that can be estimated with the current data. While this approach precludes the possibility of calculating product economies of scale and scope measures, general measures are still obtainable.

The difference between the approach adopted here and that of former studies that have included a branch variable is that it is recognized that firms can expand production through adding branches even when it is more costly than increasing production at the existing branches. The functional form adopted in Eq. (2) nests the most commonly used alternative functional forms, namely the ''pure'' cost function with no branch variable in Eq. (2a), which we refer to as the traditional model I, and the cost function with a linear branch term in Eq. (2b), or traditional model II:

$$C = \alpha + \beta \Sigma p_i x_i + \gamma \Sigma (p_i x_i)^2 + \delta \Sigma\Sigma p_i p_j x_i x_j, \quad i \neq j, \tag{2a}$$

$$C = \alpha + \beta \Sigma p_i x_i + \psi k + \gamma \Sigma (p_i x_i)^2 + \delta \Sigma\Sigma p_i p_j x_i x_j, \quad i \neq j. \tag{2b}$$

Firm-level and branch-level economies of scale measures will be produced. The overall economies of scale are defined as (Baumol et al., 1982)

$$S_N = C(x) / \Sigma x_i C_i \tag{3}$$

where $C(x)$ = total cost of producing N products, x_i = the amount of product i produced and $C_i = \delta C / \delta x_i$, the partial derivative of C with respect to x_i. There are increasing, constant and decreasing economies of scale as S_N is bigger, equal or smaller than unity. The branch-level measure is obtained by holding all the branch variables constant [6].

The measure of economies of scope is

$$S_E = \left[C(x_{N-i}) + C(x_i) - C(x_N) \right] / C(x_N). \quad (4)$$

The costs of producing the sets of products $(N-i)$ and (i) separately are summed together, and the cost of producing the whole set (N) is subtracted. This figure is then divided by the cost of producing the whole set (N) of products. There are economies (diseconomies) of scope if S_E is positive (negative).

In the insurance literature on cost functions, no agreement has been reached as to what measure of output to use. Skogh (1982) notes that premium income understates economies of scale, and suggests claims expenditure as a measure of output. Cho (1988) criticizes the use of claims as a measure of output, and suggests premium income. Subsequently, both have been used (see Suret, 1991, Cummins and Weiss, 1993, and Yuengert, 1993). None of these studies includes branches as an explanatory variable. Locational oligopoly models referred to earlier show that price (premiums) can be correlated with size, and thus price is a potentially biased measure of output. Since a natural candidate for measuring output is the number of units (of a given product i) produced, this measure is used here.

For the estimations of economies of scale in portfolio management, the dependent variable is the percentage of premiums that the firm retains after paying all claims [7]. For the portfolio management estimations, a longer observation period (1984–1991) will be used. The following explanatory and control variables are used: premium income and squared premium income (deflated by the consumer price index) [8] and the number of branches (using 1989 data) to measure economies of scale and the captivation effect respectively. Economies of scope are measured by an inverse Herfindahl-index of a firm's portfolio calculated as follows:

$$HHI = \Sigma (x_i / \Sigma x_i)^{-2}$$

where x_i is the premium income of line i. The larger this measure, the more diversified the portfolio of the firm. The share of each of the two compulsory lines of insurance in a firm's portfolio are also used as control variables.

[6] An expanding part of the cost function literature studies branch level economies of scale and scope using branch level data (Zardkoohi and Kolari, 1994) use Finnish banking data.

[7] There is a separate appendix detailing how these profit measures were calculated from the financial statements of the firms, and how firms were merged. This appendix is available from the author upon request.

[8] There is an inherent difficulty here. It is not at all clear that the consumer price index truly reflects the price inflation in the insurance market. However, it was felt that using it as a deflator will produce numbers that are less biased than the numbers from the other possibility, namely no correction for inflation. To check the effect of this, portfolio management estimations were done with deflated and nominal premiums, and the results are both qualitatively and quantitatively same. The results from the nominal estimations are available from the author upon request.

The portfolio management estimations are close in spirit to those using the profit function approach (Berger et al., 1993) but there are important differences. For example, the profit function approach encompasses the production side and the portfolio management side. Also, it assumes perfect competition. Since the Finnish non-life insurance market is highly concentrated and there exists no conclusive evidence (Toivanen, 1995) that it would be perfectly competitive, we cannot a priori make this assumption.

The cost function results are used to quantify the cost effect. Likewise, the results of the portfolio management estimations are used to quantify the captivation effect. If the former is negative (i.e., costs increase as a function of the number of branches), the latter should be positive.

4. Empirical results

4.1. Cost function results

The quadratic cost functions above were estimated using a three-year (1989–1991) data set. We assumed that there are no firm effects, but allowed the constant term to vary over time by introducing year dummies. The stochastic frontier specification was as follows:

$$\boldsymbol{C} = \boldsymbol{bX} + \boldsymbol{dD} + u + v(i) \quad (5)$$

where $\boldsymbol{X}$, $\boldsymbol{D}$ ($\boldsymbol{X}$ representing explanatory variables, $\boldsymbol{D}$ time-dummies) and $\boldsymbol{C}$ are matrices and there is an additional half-normally distributed firm specific error term, $v(i)$, which measures the distance of firm i from the frontier.

The results of the estimations are presented in Table 2. The constant term is negative in all three estimations whereas the linear output term always has a positive and significant coefficient. Squared output obtains a negative and significant coefficient for both traditional models, but an insignificant positive one for the preferred specification. The crossproduct output term *XZ* carries a significant negative coefficient throughout, but the crossproduct term between output and the number of branches, *XK*, is insignificant. The number of branches has an insignificant negative coefficient for the preferred specification and a positive and significant one for traditional model II. The coefficient of the squared number of branches is positive and significant, meaning that firms with more than one branch are not minimizing firm level operating costs. This evidence supports the cost effect and oligopolistic competition (consistent with research hypothesis H_1) and implies that we should find a positive captivation effect in the portfolio management estimations. There are three measures for economies of scale – one at the firm level and two at the branch level. The branch level measures differ in the number of branches (i.e., the first one is calculated at the level of just one branch, and the second at the level of the mean number of branches). The measures for

Table 2
Estimation results for the quadratic cost function [a]

Variable	Preferred model	Traditional model I	Traditional model II
Constant	−10620	−23073	−29184 *
	(11060)	(16680)	(14790)
X = output of product i	0.18475 * * *	0.32569 * * *	0.24535 * * *
	(0.02956)	(0.02689)	(0.05677)
XX = squared output	0.38E−07	−0.41E−06 * * *	−0.31E−06 * * *
	(0.66E−07)	(0.41E−07)	(0.76E−07)
XZ = crossproduct of output variables	−0.16E−06 * * *	−0.95E−08	−0.13E−07
	(0.22E−07)	(0.23E−07)	(0.19E−07)
K = number of branches	−753.21	–	1474.2 * * *
	(585.2)		(795.1)
KK = squared no. of branches	48.018 * * *	–	–
	(9.154)		
XK = crossproduct of branch and output variables	0.37E−11	–	–
	(0.17E−10)		
$\sigma(u)/\sigma(v)$	2.5011	2.0186 * *	3.7356
	(1.910)	(0.8469)	(2.903)
$[\sigma^2(u)+\sigma^2(v)]^{1/2}$	36940 * * *	51074 * * *	49903 * * *
	(6057)	(11070)	(6938)
Avg. ineff. (Jondrow et al.)	28997	42634	369059
	(24.2%)	(35.5%)	(32.9%)
log L	−726.92	−751.09	−744.22
LR-test (d.f.)		48.52 * * * (3)	34.77 * * * (1)

[a] Numbers in parentheses are standard errors. LR-test = LR-test against the preferred specification with degrees of freedom in parentheses.
* = significant at the 10% level.
* * = significant at the 5% level.
* * * = significant at the 1% level.

Table 3
Estimates of economies of scale and scope [a]

Measure	Preferred model	Traditional model I	Traditional model II
S_N firm level	0.77773 * * *	1.93708 * * *	1.40104 * * *
S_N (K = 1)	10.691	–	1.83008
S_N (K = 22)	12.775	–	2.7511
S_E (K = 1)	3.5953 * * *	1.071 * * *	1.1550 * * *
S_E (K = 22)	3.2025 * * *	–	1.1031 * * *

[a] S_N = economies of scale (test for difference from unity); S_E = economies of scope (test for difference from zero); K = 1 (measured at level of firm having one branch); K = 22 (measured at level of firm having the mean no. of branches).
* = significant at the 10% level.
* * = significant at the 5% level.
* * * = significant at the 1% level.

economies of scope are calculated at two levels, similar to the branch level economies of scale measures. Measures for all three functional forms are presented in Table 3.

A LR-test (i.e., values are 48.52 and 34.77 with 3 and 1 d.f.) clearly rejects both traditional specifications. As can be seen from Table 3, the proposed specification exhibits diseconomies of scale at the firm level as S_N gets a value significantly lower than unity (0.78), but statistically insignificant economies of scale at the branch level. The larger is a firm's branch network, the stronger is the cost effect. There are overall significant economies of scope ($S_E > 3$). The traditional specification with no branch variable exhibits large, significant economies of scale at the firm level ($S_N = 1.94$) and smaller economies of scope than the preferred specification ($S_E = 1.07$ compared to 3.60). The functional form with a linear branch term exhibits significant economies of scale at firm and branch levels. Also, the scope estimate is closer to the traditional model I than to the preferred model [9].

The measured average inefficiency level was 24 percent of operating costs [10]. The difference between the mean inefficiencies of both traditional models and the preferred model was positive and statistically significant (with t-ratios of 2.92 and 2.47 for the differences between the preferred model and traditional models I and II, respectively, confirming the hypothesis H_3). The estimation results showed that the difference is a decreasing function of branches, but an increasing function of the squared branches. Between the preferred model and traditional model I (without branch variable), the difference is positive for all nonnegative values of the branch variable. Between the preferred model and traditional model II, the difference becomes positive at the level of 51 branches. Thus, the hypothesis that the difference is a positive and increasing function of the number of branches is supported.

4.2. *Quantification of the cost effect*

As the operating costs are an increasing function of the squared number of branches and there are constant or increasing returns to scale at the branch level, a cost effect does exist – firms with more than one branch do not minimize their

[9] Earlier non-life insurance studies usually report economies of scale. Suret (1991) finds economies of scale in Canadian property and liability insurance firms with assets between 40 and 100 million Canadian dollars; Cummins and Weiss (1993) find economies of scale for firms with net premiums under 500 million U.S. dollars and diseconomies of scale for larger firms in the U.S. property-liability insurance market; Yuengert (1993) finds economies of scale in U.S. life insurance firms up to asset sizes of 15 billion U.S. dollars; and Fecher et al. (1992) find economies of scale in the French non-life insurance industry.

[10] Cummins and Weiss (1993) report inefficiencies between 10 and 20 percent while Yuengert (1993) reports them at between 35 and 50 percent for life insurance.

Table 4
Estimates of the cost effect [a]

A. Effects of economies of scale

Firm ranking (size)	Number of branches	Total operating costs (1991, 1000 FIM)	$\psi K + \rho KK$ with existing no. branches (1000 FIM)	Difference to $\psi K + \rho KK$ with mean no. of branches (22)	Difference to $\psi K + \rho KK$ with min. of big firms' branches (50)	Difference to $\psi K + \rho KK$ with max. of small firms' branches (34)
1st	107	705034	469164	462495 (66%)	386780 (55%)	439265 (62%)
2nd	83	591519	268280	261610 (44%)	185895 (31%)	238380 (40%)
3rd	67	302548	165088	158418 (52%)	82703 (27%)	135188 (45%)
4th	63	268733	143131	136461 (51%)	60747 (22%)	113232 (42%)
5th	50	360184	82385	75714 (21%)	0 (0%)	52485 (15%)
Σ				1094697 (49%)	716125 (32%)	978549 (44%)

B. Effects of economies of scope

Firm ranking (size)	Number of branches	Total operating costs (1991, 1000 FIM)	Difference to δXY with mean no. of branches (22)	Difference to δXY with min. of large firms' no. of branches (50)	Difference to δXY with max. of small firms' no. of branches (34)
1st	107	705034	−618 (0.08%)	−314 (0.04%)	−131 (0.02%)
2nd	83	591519	−1110 (0.16%)	−180 (0.03%)	−624 (0.09%)
3rd	67	302548	−1150 (0.16%)	−217 (0.03%)	−662 (0.09%)
4th	63	268733	−1120 (0.16%)	−189 (0.03%)	−634 (0.09%)
5th	50	360184	−932 (0.13%)	0	−445 (0.06%)
Σ			−4931 (0.22%)	−271 (0.01)	−2495 (0.11)

[a] Numbers in parentheses in columns 3–6 are per cents of total operating expenses.

costs. It is of interest to consider how much these firms pay for a large branch network in terms of increased operating cost. There are five firms with branch networks that clearly exceed the size of the average branch network. We ask the following question: how much would the operating costs of these five firms decrease if they operated a smaller branch network but kept their output at the current level? To answer this, we chose three thresholds for the number of branches:

1. the mean number of branches (22) rounded to the nearest integer,
2. the number of branches in the smallest of the five large firms (50), and
3. the number of branches in the small firm with the most extensive branch network has (34).

These thresholds allow us to calculate the extra costs of a large branch network. The results of these calculations are presented in the first section of Table 4, where both the market total, and the firm-level extra costs arising from branch proliferation are reported, as well as the percentage that these extra costs represent from the total operating costs of the firms. The big firms appear to forego substantial economies of scale in order to gain market power, as even the lowest average estimate indicates that 32 percent of the operating expenses are due to the cost effect.

It could be possible that the extra costs from branch proliferation could be alleviated via economies of scope, if those firms with a large branch network were able to offer more lines on insurance than firms without a branch network [11]. The results of these calculations are shown in the second section of Table 4. A large branch network results in a cost reduction via economies of scope, but the effect is of a smaller magnitude than the effect via (dis)economies of scale. Compared with the mean inefficiency-measure which is 9.1 percent (45,592,000 FIM) for the five firms with large branch networks, the figures for branch proliferation are higher. Apparently a nonnegligible part of the operating expenses of Finnish non-life insurance firms are due to branch proliferation.

4.3. Estimates of economies of scale in portfolio management

In this section the branch variables are expected to capture those effects on portfolio management that do not come from just increasing the size of the portfolio. As an example, one of the largest firms has just one branch, and might

[11] To study this, we regressed the number of lines a firm is providing in 1989 on some control variables, and the linear and squared number of branches. Firms with a large branch network are likely to be active in more lines of business. The estimation results are suppressed in order to save space, but are available from the author upon request.

Table 5
Results from the portfolio estimations [a]

Variable	Random effects model Insurance portfolio	Fixed effects model Insurance portfolio
Constant	6.438(4.368)	49.455 *** (21.21)
PREM	−0.00936 * (0.00542)	−0.05769 ** (0.02729)
PREM2	–	0.000013113 * (0.00000593)
K	0.3098 ** (0.1568)	–
HHI	0.5374(0.395)	−0.3954(0.5490)
TRAFF	–	−0.72002(0.4908)
ACC	–	−0.45399(0.8509)
R^2	0.1039	0.788
LM-test	153.66 ***	–
F-test(31,108)	–	12.96 ***

[a] LM-test against a model with only firm effects and no explanatory variables. F-test on joint significance of explanatory variables (d.f.). Numbers in parentheses are standard errors.
* = significant at the 10% level.
** = significant at the 5% level.
*** = significant at the 1% level.

still enjoy economies of scale in portfolio management but would not be able to reap the (market power or informational) benefits that accrue from having a large branch network if they existed. The potential benefits of the branch network include shear size and the associated captivation (or oligopolistic competition), information (i.e., better monitoring of customers) and reputation effects. In this respect, we expect to find a positive captivation effect as reflected in a positive branch coefficient.

The observation period is 1984–1991. The results of the portfolio management estimations are presented in Table 5. There are decreasing economies of scale as PREM carries a negative and significant coefficient when using a one-way random effects specification [12]. This result is reinforced by the fixed effects specification results where PREM also has a negative coefficient. The squared premiums variable [13] has a positive coefficient and hence the (premiums-claims)/premiums-curve seems to be U-shaped with a unique minimum around 4 billion FIM. The largest firm in the sample has a premium income of 3 billion FIM such that all firms in the sample operate under decreasing returns to scale. Another finding is that there are no economies of scope (i.e., HHI is not

[12] A one-way random effects model was used since there is data on the number of firms only for one year. Because of the relatively low explanatory power of the estimation, a (two-way) fixed effects model was also estimated.

[13] PREM2 was insignificant in the random effects estimation and was dropped.

Table 6
Estimates of the captivation effect, and comparisons [a]

A. Estimates of the captivation effect

Firm ranking (size)	No. of branches	Total operating costs (1991, 1000 FIM)	Difference in PCM to a firm with mean no. of branches (22)	Difference in PCM to a firm with min. no. of large firms' of branches (50)	Difference in PCM to a firm with max. of small firms' branches (34)
1st	107	705034	661740 (94%)	443755 (63%)	568318 (81%)
2nd	83	591519	393309 (66%)	212774 (36%)	315937 (53%)
3rd	67	302548	192752 (64%)	72817 (24%)	141351 (47%)
4th	63	268733	123122 (46%)	39039 (15%)	87086 (32%)
5th	50	360184	65332 (18%)	0	37336 (10%)
Σ			287252 (58%)	192096 (34%)	230005 (45%)

B. Combined cost and captivation effect

Firm ranking (size)	No. of branches	Total operating costs (1991, 1000 FIM)	Difference to a firm with mean no. of branches (22)	Difference to firm with min. of large firms' no. of branches (50)	Difference to a firm with max. of small firms' no. of branches (34)
1st	107	705034	199810 (28%)	57257 (8%)	129194 (18%)
2nd	83	591519	132646 (22%)	27056 (5%)	78089 (13%)
3rd	67	302548	34818 (12%)	−9795 (−3%)	6436 (2%)
4th	63	268733	−12909 (−5%)	−21627 (−8%)	−25903 (−10%)
5th	50	360184	−9909 (−3%)	0	−14933 (−4%)
Σ			68891 (11%)	13223 (0.4%)	34577 (4%)

Table 6 (continued)

C. Cost and captivation effect together with diseconomies of scale in portfolio management

Firm ranking (size)	No. of branches	Operating costs (1991, 1000 FIM)	Difference to a firm with the min of large firms' no. of branches (22)	Difference to a firm with min. of large firms' no. of branches (50)	Difference to a firm with max. of small firms' no. of branches (34)
1st	107	705034	180892	40 786	108 478
			(26%)	(6%)	(15%)
2nd	83	591519	117769	14 626	61 113
			(20%)	(2%)	(10%)
3rd	67	302548	26480	−15 686	−4 001
			(9%)	(−5%)	(−1%)
4th	63	268733	−17379	−23 650	−32 472
			(−6%)	(−9%)	(−12%)
5th	50	360184	−12356	0	−19 479
			(−3%)		(−5%)
Σ			59080	4 019	22 728
			(9%)	(−1%)	(−1%)

[a] Numbers in parentheses in columns 3–6 are percents of total operating expenses. The values in the Σ-rows are averages of 1000 FIM and of percentages respectively.

significant) which is surprising because standard portfolio theory would suggest that there are economies of scope in managing a portfolio. Additionally, the coefficient of BRANCH is positive and significant. That is, consistent with research hypothesis H_2, firms with large branch networks have a larger premium-claim-ratio than other firms and are thus able to exercise market power.

4.4. Quantification of the captivation effect and comparisons with the cost effect

Gains produced by a large branch network were calculated in 1000 FIM and as a percentage of operations costs (using the same three thresholds as in quantifying the cost effect of branch proliferation). The results of these calculations are presented in three parts in Table 6: (A) the captivation effect (i.e., the increase in the premium-claims-ratio due to a large branch network); (B) the combination of the cost and captivation effects which should be positive in order to justify a large branch network; and (C) combination of the cost and captivation effects with the diseconomies of scope from managing a large portfolio. As shown there, captivation effect results in large gains with the lowest average gain (as a percentage of operation costs) being 35 percent and the largest gain over 90 percent. The second part reveals that for most firms and most thresholds, the captivation effect is larger than the cost effect, as expected. However, for only the two largest firms is the captivation effect always larger than the cost effect; other firms, especially the two smallest ones, seem to lose more than they gain. These results are further confirmed in the third part, where the diseconomies of scale in portfolio management are taken into account – the two largest firms gain from branch proliferation but the three next ones do not. This result might, however, be consistent with the firms' objectives. Although no difference has been made between stock- and mutual firms, different ownership forms might provide an explanation for the above results. The two largest ones (and the fifth largest) are stock owned, and should hence maximise profits. The third and fourth largest, however, are mutual firms, and it is usually assumed that the objective of a mutual firm is not profit maximisation, but the maximisation of customer (i.e., owner) welfare. This could well be consistent with lower margins and a "too large" branch network from a profit maximisation point of view.

The results provide an alternative explanation to the scale efficiency puzzle from that offered by McAllister and McManus (1993): they found that including financial capital as an explanatory variable increased the size range over which banks enjoy increasing returns to scale. They also found that after that size, there exist constant, not decreasing returns to scale. We found constant (or increasing, although insignificantly so) returns to scale for firms with one branch, and decreasing returns to scale for any branch network with more than one branch. The explanation is that although there exist diseconomies scale (the cost effect), they are more than outweighed by the gains (the captivation effect) made possible by the oligopolistic structure of the Finnish non-life insurance industry.

5. Conclusions

This study assumes that the relevant unit of production in (financial) services production is the branch. The market power that is achieved by a large branch network is often potentially exploited by setting prices to a different level than smaller rivals. Theory suggests that an industry can simultaneously have increasing returns to scale at the branch level and decreasing returns to scale at firm level. This theory was used to estimate economies of scale and scope and the degree of (in)efficiency in the Finnish non-life insurance industry. A technique was developed that allowed the estimation of a cost function on a limited set of data. The traditional functional forms were rejected. We found constant returns to scale at the branch level, and diseconomies of scale at the firm level. Economies of scope exist, but they are modest in size.

To the best of our knowledge, this is the first study to address the issue of economies of scale in portfolio management in insurance, although there exist profit function studies in banking that take into account the revenue (portfolio) side of the business. The share of retained premiums was U-shaped with respect to portfolio size. However, all firms in the sample operate under decreasing returns to scale in portfolio management.

The cost function estimations provided evidence on the cost effect, and the portfolio management estimations were relevant to the captivation effect. Existence of the captivation effect is equal with the large firms having market power through their branch networks. These effects were quantified and compared. Both the cost and the captivation effects appeared to be large – the smallest average estimate for firms with the five largest branch networks was over 30 percent of operation costs for both measures.

Earlier studies on cost functions have, implicitly or explicitly, maintained the neoclassical assumption that the cost function is the dual of the production function. Even if a branch variable has been used, the assumption has been made that new branches are added only if economies of scale at the existing branches have been exhausted. The results of this study suggest that branch proliferation can occur for reasons other than cost effects.

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