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ABSTRACT

Oligopolistic services and branch network decisions are studied. There are two opposing effects when a firm decides the number of branches: the *captivation effect* of increasing market power, and a *cost effect* of average costs. These ideas are formalized in a two-city Hotelling model. Firms face two cost functions: the *technical cost function*, given by production technology and the *perceived cost function* which reflects also market characteristics. There are economies of scope and diseconomies of scale at firm level and economies of scale at branch level in Finnish non-life insurance, as predicted by the model.

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1. Introduction

Researchers have for some time now acknowledged that in services industries, firm- and branch-level measures of economies of scale can be different (*economies of density;* Caves et. al. 1986, *overall economies of scale*, Hardwick 1990), and the branch variable is fitted into the empirical specification as standard. No rigorous theoretical explanation has however been given as to why this should be. This is the main objective of this paper. Starting from the observation that the actual service, be it insurance, banking or retailing, is produced at the branch(es), and constructing a game-theoretic model where the firms can choose both the location and number of their branches, and the degree of brand differentiation, I show why it might be that firms forego even considerable economies of scale at the branch level and expand their branch network. The lessons of the theoretical model are taken on board when specifying the empirical cost function which is then estimated on data from the Finnish non-life insurance industry. This industry has been relatively neglected in terms of modern cost function studies. The Finnish case is especially interesting here because of the special features of the market: a large, sparsely populated market, partly regulated products, only a handful of firms, and a huge number of products underline the incentives of firms to open new branches, and represent some challenges in terms of the empirical specification. In the empirical part, I find economies of scale at the branch level, and diseconomies of scale at the firm level. The cost of branch proliferation are also estimated, and it turns out that the firms with a large branch network pay (in terms of foregone economies of scale at branches) a considerable amount for their branch networks.

This paper rests on the observation that in services (and retailing, which from now on will be subsumed under the heading of services), the principal unit of production is the branch, and the production technology used lies on this level. There can be important functions, such as logistics, that are not performed at branch level, but the actual product that the customer buys is produced there. Another observation (which is hardly new) is that the branch network is one of the strategic tools in the toolbox of services firms. Branches, through their location, are used to increase market power. As an example, think of a supermarket chain operating in the area of greater London, and another operating in Sweden that both use exactly the same technology. Both have a clientele of roughly 8 Mio., but these are located much more densely in London. To reach all potential customer the supermarket chain in London probably needs a number of branches that is far smaller than the number of branches needed in Sweden. If we assume that both chains sell the same amount of goods, then the chain in Sweden will have higher average costs because of the bigger number of branches. But even the London firm will probably not rely on just one store, even if this was technically feasible. If the only costs above the variable (=marginal) costs of purchasing the goods from manufacturers are the fixed costs of establishing a branch, then one store would be the cost minimizing solution for the supermarket chain. But the chain will have several in order to optimize the mix between market power and costs.

There are two effects at work: *the captivation effect* of increasing market power through additional branches, and *the cost effect* of (possibly) increasing average costs, that the firm has to balance when deciding whether to increase output at the existing branch(es) through lower prices, or to add another branch to the network. A profit-maximizing firm thus does not necessarily minimize firm level costs, as assumed in neoclassical production theory. This means that the firm-level cost function is not the dual of the production function, as traditional theory claims, but this relationship holds at the level of production unit, the branch. The above suggests that it is entirely possible, and if the fixed costs dominate variable/marginal costs, even probable, that we can observe situations where an industry exhibits increasing returns to scale at branch level, and diseconomies of scale at firm level. We would have to separate two levels of the cost function: the *technical cost function*, and the *perceived cost function*. The former is dictated solely by production technology. The latter (minimizing it is consistent with profit maximization), tells us the optimal (=profit maximizing) path of costs as a firm expands its output, given the market characteristics (number of customers, market area, level of competition). The perceived cost function is the envelope of the technical cost function, as the latter can never lie higher than the former, but they can coincide.

The above observations have major consequences for the estimation of cost functions of services industries. These are discussed in more detail in a later section. The empirical part of this paper consists of constructing and estimating a cost function (frontier) for a services industry that, especially relative to its importance for the functioning of a modern economy, has received little attention, namely insurance. The limitations of the data, a large number of products (39) and a small number of firms (21) requires some restrictions on the cost function so that results can be obtained. These are imposed so that general measures of firm- and branch-level economies of scale and scope can be obtained, the price being that product-level measures become unobtainable.

The rest of the paper is organized as follows. In the next section, a theoretical model is constructed and solved in order to analyze the above discussed insights. The model shows that it is entirely possible that profit-maximising firms do not necessarily minimise costs in a multimarket environment in the way traditional models assume. In the third section, the data and the market under study, the Finnish non-life insurance market, are discussed. In that section, the empirical model is constructed. I also compare it to those used in the existing literature. The fourth section contains the empirical results, and some comparisons to existing literature on cost function estimations in banking and insurance. The fifth section concludes.

2. A model of branch networks

A branch network is strongly connected to the idea of clusterings of customers. Whether you think of a nation-wide branch network or a branch network in a single city, then each branch usually services a different set of customers. The study of oligopolies in a multimarket setting using game-theoretic tools is a fairly recent phenomenon: examples of such studies are Brander&Eaton (1984), Lal&Matutes (1989), Shaked&Sutton (1990) and Dobson and Waterson (1993)[1]. They specify the different markets in terms of different products, not different geographical markets, and as will be clear, this makes a difference. The existing product differentiation models have their drawbacks with regard to this paper's objectives: they either allow only one-dimensional product differentiation (e.g. the standard Hotelling and its extensions. For the latter, see Eaton&Lipsey, Ben-Akiva, de Palma&Thisse 1989), or they do not easily allow for discontinuously distributed customers (e.g. hexagonal city, see Nooteboom 1993, discrete choice models, see Anderson, de Palma&Thisse 1992).

The situation that I want to model is the following: think of two nearby cities, *A* and *B*, one (*A*) possibly larger that the other. Or think of a city centre and a suburb. There is a travelling cost to get from one city to the other. Furthermore, potential customers are heterogenous when it comes to their tastes, and some are always willing to make the trip to get their preferred product. I am thus assuming that difference in tastes is greater than that in locations. This is an important assumption, since it will guarantee continuous, monotonic demands for the firms. Let the firms choose their location both with regard to tastes and geographical location. They can, however, only occupy one location on the taste axes. This means that they sell the (physically) same product in both cities. But they can have two branches, one in each town.

The population of each city is uniformly distributed on a line of length one. The density of customers is 1 in the smaller city *B*, and $\alpha \geq 1$ in the larger city *A*. This line represents the tastes of the customers, and there is a disutility, d, that affects the utility derived from a product if the product's location on the taste line does not correspond to the location of the customer. I will assume that this disutility is quadratic in distance, as in e.g. Bonanno (1987). Further, it is assumed that the distance between the cities is t, reflecting the transport cost of travelling from one city to the other and back. This cost does not depend on a customer's location on the taste line, but is the same for all customers in the model. Modelling the transport (and disutility) costs in this way corresponds to the intuition of them being independent of the amount of goods bought (although I will assume that each consumer buys at most one good). To guarantee well behaving demand curves, I will assume that the disutility cost of tastes is always greater than the transport cost, $t \leq d$.

Call the two firms *1* and *2*. To study the location decisions, I will assume that the firms make their location choices sequentially, and that it is firm *1* that acts first. This gives the following structure:

1. Firm *1* chooses its location on the taste line, and the geographical location of its first branch
2. Firm *2* -------- " --------
3. Firm *1* decides whether to open a branch in the city where it does not have a branch
4. Firm *2* -------- " --------
5. Firms compete in prices

There is a fixed cost that has to be incurred when a branch is opened. For simplicity, I will assume that this cost, denoted *K*, is constant (it could be made to vary with the number of branches, so that it would be either lower or higher for the second branch than for the first one). The following assumptions (a complete list is presented in the appendix) are made: it is always profitable for both firms to establish at least one branch (they enter if expected profits are nonnegative); in case of ties, the firm prefers to locate in *A*; the reservation utility, homogenous over all customers, is low enough to guarantee full market coverage even for a monopoly with one branch; a firm has to set a uniform price (no intra-firm price discrimination); the production process is homogenous over firms at branch level (ie. product differentiation in tastes does not affect the production costs); marginal costs are zero

If the transport cost t decreases, the model approaches the standard one-city Hotelling model, with a different customer density. If the taste disutility parameter d decreases, it means that t decreases, too (because of the assumption $t \leq d$), and the model approaches the standard Bertrand model of competition in prices. The model takes the form of an *H*, where the vertical taste dimension is longer than the horizontal geographical dimension (see fig. 1). The customers are thus located on the vertical lines.

FIGURE 1 SOMEWHERE HERE

There are several possible combinations of geographical location. The firms could have just one branch each, and locate them in different cities (2 possibilities: *1* at *A* and 2 at *B* or vice versa), or in the same city (again two possibilities). One of the firms (with the assumption made, firm *1*) could have two branches, whereas the rival has just one. The rival's branch can be in either city, giving again two possibilities. Lastly, both firms could opt for two branches. There are thus seven locational outcomes in theory. Consider now a customer in city *A*, who is located at x. Her cost of acquiring firm *1*'s product is either

(1) $p_1 + dx^2$

or

(2) $p_1 + dx^2 + t$

and similarly for firm 2, the only changes being the subscript of p, the price, and a change of distance measure to $(1-x)$. It is easy to solve for x, thus getting the demands of the two firms in city *A*. The first proposition concerns the location of firms on the taste line.

proposition 1: the firms locate at the ends of the taste line.

A proof of this proposition can be found eg. in Tirole (1988). This is a standard result of the Hotelling model with quadratic transportation costs, and the addition of another city to the model does not affect this result. If it is not profitable to have more than one branch per firm, the only thing that the firms have to decide is where to locate their branches. The following proposition states the result:

proposition 2: if it is not profitable for either firm to open more than one branch, then the firms will choose different locations, and firm *1* will open its branch in the bigger city *A*.

The proof of all the propositions are relegated to the appendix. As proposition 2 shows, there is only one possible equilibrium out of four possible ones, when the firms' optimal number of branches is 1. It is possible to prove the following proposition regarding the one branch per firm equilibrium:

proposition 3: If the optimal number of branches per firm is 1, then firm *1* (located in *A*) sets a higher price and has a higher demand.

Intuitively, by positioning its branch in city A firm *1* captures the clientele there. This clientele is bigger than that in city B. The optimum for firm *1* turns out to be to exercise its market power through a higher price than its rival. This means that it surrenders some of its captive customers to firm *2*, but squeezes a bigger slice of surplus out of the remaining ones. For this to be an equilibrium, it must not be profitable for either firm to open a new branch.

If the situation is changed so that (at least) one firm finds it profitable to open another branch despite an increase in fixed costs, the location decisions of the other firm is affected:

proposition 4: If it is profitable for just one firm (firm *1*) to open two branches, then its rival will open its branch in city A. Firm *1* will set a higher price, and have a higher demand than its rival.

Firm *2*'s optimal location thus depend on whether or not it is profitable for firm *1* to open two branches. With the assumption of perfect information used here, this does not matter for firm *1*, but if there were some uncertainty on, say the sizes of clientele in the two cities, then firm *2*'s choice of location would act as a signal to firm *1*. To get this asymmetric equilibrium in branches, it must be profitable for firm *1* to open a second branch, and unprofitable for firm 2 to counter that move by opening its second branch. It is possible that both firms open two branches, but this is a prisoner's dilemma type of outcome: both firms would then prefer both of them having just one branch.

proposition 5: If firm *1*'s profits are higher with two branches than with one given that firm *2* has just one branch (and then the same applies to firm 2), and if firm *2*'s profits are higher with two branches than with one given the number of firm *1*'s branches, then the equilibrium number of branches is two for both firms. The profits are, however, lower compared to a situation where both firms would have just one branch.

Let's take the viewpoint of firm *1* on stage 3 of the game. The firm has to decide whether or not to open a second branch. Given the contents of proposition 5, the firm knows that if it does not open a second branch, firm *2* will. Since the firm's profits would be lower if it has just one branch and its rival two, compared to both having two, it decides to open a second branch. Then change to firm *2* in stage 4: since firm *1* already has two branches, and firm *2*'s profits are lower with one than with two branches, it opens a second branch. But since I have assumed that the market is covered, this means that there is duplication of fixed costs without any increase in either prices or demand. Thus the firms lose the fixed costs of the second branch, compared to their first best. And actually, they lose even more, since their first best would also entail different geographical location according to proposition 1, and thus higher profits.

The last proposition is probably the most important one, especially with regard to the empirical section:

proposition 6: An oligopolistic firm that maximizes profits does not necessarily minimize costs.

This is clear from the cases where either firm has more than one branch: the whole market is covered with just one branch per firm (with the assumptions made, even with a monopoly with one branch), but despite this firms can find it profit maximizing to open a second branch, thereby duplicating fixed costs and increasing average costs (since for neither firm does the demand more than double, which is a necessary condition for average costs to decrease after the opening of the second branch).

The link between the above model and the empirical part of the paper is indirect in the sense that I do not derive a cost function from the model. The main purpose of the model, in this paper's context, is to show, via an example, that cost minimisation in terms of the technical cost function (as is assumed in traditional literature) does not always coincide with profit maximisation. The minimisation of the perceived cost function, that takes the market characteristics and competition into account, is in line with profit maximisation, however. The model gives a theoretical justification for the researcher to include the branch variable into a cost function, guidance on how it should be treated and how one should interpret the different coefficients.

To sum up the results that are relevant for the empirical part of this paper: it is a possibility that an oligopolistic firm does not minimize costs, but is engaged in branch proliferation. Also, this means that firms forego potential economies of scale at branch level in order to gain market power. These equilibria thus display diseconomies of scale at firm level and economies of scale at branch level, as suggested in the introduction. The technical and the perceived cost functions are different in these circumstances. Furthermore, a bigger firm (whether with one or two branches) sets higher prices to a good that has the same production costs. This means that turnover (or, in the case of insurance, premium income) is a biased measure of output, whether at product or firm level. A correct measure of output is the number of units sold, since this reflects truthfully the production volume, and hence the costs, of a firm.

One of the technical developments of recent years in cost- and production function literature are frontier estimations (see e.g. Bauer 1990, and for a mathematical programming approach e.g. Seiford&Thrall 1990). These allow the researcher to relax the assumption that all firms use efficiently all their inputs. The theoretical model 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 efficiency. The reason is that 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 output) incurred in opening branches are interpreted, to the extent that the they are not subsumed into the estimated output coefficients, as inefficiency. The correct specification allows the researcher to separate these effects into costs of branch proliferation and inefficiency. Theory thus suggests that traditional functional forms give a measure of inefficiency that is biased upwards (too much inefficiency), and that this bias is positively related to the number of branches.

3. The data, the market and the empirical model

The data used in this study is from the Finnish non-life insurance market. This market provides an interesting test-bed for several reasons. All the firms rely on branches for distribution, and there are (almost) no brokers during the observation period 1989-1991. Thus it can be assumed that all firms rely on the same (or at least, closely related) technology. There are big differences in the sizes of the branch networks, the largest ones comprising of over a hundred branches, whereas the majority of firms rely on just one branch. The number of products, as listed in Statistics Finland: Insurance[2], is large: 39 lines can be found for which both quantity and price (=premium income) data is available. The actual number of lines sold is even bigger, since for some categories, only the aggregate number of policies sold, or the aggregate premium income was available. The large number of products (=lines of insurance) together with the relatively small number of firms (21) makes it necessary to constrain the cost function in order to obtain any estimates. The large geographical size (over 300 000 sq. km.) relative to population (5 Mio.) suggests that in Finland, a branch network is an effective means to increase market power. This should mean, then, that the interplay between the captivation effect and the cost effect should figure prominently in the optimization problem that the firms face. This is indeed found to be the case, as will become clear when the empirical results are discussed.

TABLE 1 SOMEWHERE HERE

The different lines of insurance are listed in table 1, together with the number of firms providing each line of insurance in any of the years of observation, 1989-1991, and the aggregate (1991) premium income of each line together with the four-firm concentration (1991 data) ratio per line[3]. Two biggest lines, the worker's compensation and traffic insurance, are regulated and compulsory. There is both price regulation (which has been gradually relaxed during the observation period, but not abolished) and entry regulation. A firm needs a licence to provide either of these lines of insurance, and not all firms have such a licence. It is not clear how many have opted not to apply for one voluntarily, and how many have not applied after judging that the likelihood of getting a licence is too small. The regulation of these lines can, for its part, strengthen the captivation effect in that firms engage in quality competition when price competition is banned or restricted. The total number of firms in the market is bigger than that in the sample[4]. Key information regarding the firms is presented in table 2. Some of the firms are stock-owned, some mutuals. I assume that both organizational forms use the most efficient technology available. The firms can be divided into two groups. The six biggest firms behave differently compared to the rest (see Toivanen 1994a). All but one of these have a nation-wide branch network, the outlier being a firm specialising in big manufacturing customers. The other group consists of firms with heterogenous strategies: most of them have only one branch, and only one of them a national branch network. Some of them have a larger regional network, though.

TABLE 2 SOMEWHERE HERE

The standard tool of cost function analysis currently is the translog cost function (Christensen, Jorgenson&Lau 1973). This, however, has the unfortunate feature that it does not allow for zero production of any one product. In the current sample, most firms do not produce all products, and thus a translog form cost function cannot be used. In one of the most comprehensive treatment of cost functions to date, Baumol, Panzar&Willig (1982, pp. 448-450) list five key requirements for a good cost function: firstly, it should be a proper cost function, one consistent with minimization of inputs. It should be nonnegative and nondecreasing, and linearly homogenous in input prices. Secondly, it should be able to accommodate zero production of some products. Thirdly, it should not impose constraints on the data, but should be flexible. Fourthly, it should not require the estimation of an excessive number of parameters. Fifthly, it should not impose any constraints on the values of the first and second partial derivatives.

On these grounds, they end up recommending a quadratic cost function:

(3) $$C = \alpha + \beta_i x_i + \Sigma\gamma_{ii} x_i^2 + \Sigma\Sigma_{i\neq j}\gamma_{ij} x_i x_j$$

where

x_i = output of product i

The quadratic cost function has two drawbacks: Firstly, it cannot be deduced theoretically. This is in my view a minor problem, since any cost function should be viewed as a statistical (or theoretical) approximation to the true, underlying cost function. Secondly, it does not allow an easy incorporation of inputs. With the particular data set used, this should not be a big problem either. Labour accounts for a major share (over 3 years and all firms on average 56%) of operating costs, and wages are centrally negotiated at the industry level. They can thus be assumed to be constant over firms. The standard way of treating a cost function has been to estimate eq. (3) directly (for an insurance example, see Daly, Rao&Geehan 1985; for banking, eg. Lawrence 1989). Some studies have included a branch variable to "control for the number of branches" (eg. Murray&White 1983). The addition has usually been done simply by adding a linear branch-variable into equation (3). Other studies, eg. Kolari&Zardkoochi (1990) and Benston, Hanweck&Humphrey (1982), have treated the branch variable like any other variable without explicitly discussing whether branches are part of the out- or input vector.

The biggest problem empirically in this study is the large number of products. Although Baumol et. al. claim that the quadratic cost function does not "require the estimation of an excessive number of parameters", this is no longer true when the number of products is 39. A fully specified cost function would have 819 parameters. With the current data set, this would necessitate roughly 40 years of data to cover the parameters, and many more to produce reliable estimates. It is quite clear that there have been major changes in the production technology over the latest 40 year period, most notably the introduction of computers, and thus even if such data were available, it would not solve the problem. The cost function has to be constrained so that a more limited set of data is adequate for estimation. This is achieved in two steps:

1) instead of using the output measure suggested by the theoretical model, I use a modified one. To be able to sum up different products, they are translated into a common measure, money. To avoid the possible market power effects that would result in different prices for differently sized firms, I use as price the per policy premium income of the biggest firm. Firm i's premium income for any given line is obtained by multiplying the number of policies i sold, x_i by this "market-

power free" price, $\underline{p}_i$, to get the measure of output, $\underline{p}_i x_i$. This is somewhat similar to a Laspeyres quantity index.

2) I assume that the coefficients of the quadratic terms, β_i, and the coefficients of the cross-product terms, γ_i, are constant over products. To be able to achieve branch-level estimates, the branch-variables are separated.

The result of these procedures is equation (4):

4) $$C = \alpha + \beta\Sigma\underline{p}_i x_i + \psi k + \gamma\Sigma(\underline{p}_i x_i)^2 + \rho k^2 + \delta\Sigma\Sigma\underline{p}_i\underline{p}_j x_i x_j + \upsilon\Sigma\underline{p}_i x_i k \quad i \neq j$$

where

k = no. of branches

The number of parameters has been thereby cut from 819 to 6. The difference between the approach adopted here and that of former studies that have included a branch variable is twofold: here, the branches are treated as part of the output, and, it is recognized that firms can expand production through adding branches even when that is more costly than increasing production at the existing branches would be. A quote (Kolari&Zardkoochi, p. 441) illuminates the difference:"Bank managers may consider the existing bank facilities efficient, and, therefore, add branches to increase total bank output". The functional form adopted (4) nests the most commonly used alternative functional forms, namely the "pure" cost function with no branch variable (eq. (4a), which I subsequently call the traditional model I), and the cost function with a linear branch term (eq. (4b), traditional model II).

(4a) $$C = \alpha + \beta\Sigma\underline{p}_i x_i + \gamma\Sigma(\underline{p}_i x_i)^2 + \delta\Sigma\Sigma\underline{p}_i\underline{p}_j x_i x_j \quad i \neq j$$

(4b) $$C = \alpha + \beta\Sigma\underline{p}_i x_i + \psi k + \gamma\Sigma(\underline{p}_i x_i)^2 + \delta\Sigma\Sigma\underline{p}_i\underline{p}_j x_i x_j \quad i \neq j$$

The definitions of Baumol et. al. (pp. 50 and pp. 73) are used when estimates for economies of scale and scope are calculated. For economies of scale, two measures will be produced; for the firm-level and for the branch-level. The former is achieved by letting all output variables, including the branch-variable, change, and the latter by holding the branch-variable constant. The overall economies of scale are defined as

(5) $S_N = C(x)/\Sigma x_i C_i$

where

$C(x)$ = total cost of producing N products

x_i = the amount of product i produced

$C_i = \delta C/\delta x_i$, 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 from (4) and (5) by holding all the branch variables constant. The measure of economies of scope is

(6) $S_E = [C(x_{N-i}) + C(x_i) - C(x_N)]/C(x_N)$

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 from this. This is then divided by the cost of producing the whole set *(N)* of products. There are economies of scope if S_E is positive, and diseconomies of scope if S_E is negative.

In the insurance literature on cost functions, no agreement has been reached as to what measure of output to use. Skogh (1982) shows 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. The theoretical model of section 2 shows that in an oligopolistic environment, prices, hence premium income, can vary systematically with firm size, and probably produce an upward bias. The criticism of section 2's model extends beyond insurance, however. The theoretical model produces a natural candidate for measuring output, namely the number of units (of a given product *i*) produced. This requires the assumption that products in a given category are homogenous over firms, or that at least their production costs are homogenous. But these assumptions are already implicit in any cost function estimation, and thus this measure does not place any new restrictions on the empirical model.

4. Empirical results and comparisons to earlier studies

The quadratic cost function (4) was estimated using a three-year (1989-1991) data set. A stochastic frontier model was estimated. I assumed that there are no firm effects, but allowed the constant term to vary over time by introducing period dummies. The specification was as follows:

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

where ***X,D*** (***X*** representing explanatory variables, ***D*** time-dummies) and ***C*** are matrices, there is an additional observation unit (in this study, firm) specific error term, $v(i)$, which is one-sided[5], i.e. can only get positive values. It thus measures the distance of firm i from the frontier.

Descriptive statistics of the estimating variables are presented in table 3, and the results of the estimations in table 4. 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: 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 economies of scope are calculated at two levels, similarly to the branch level economies of scale measures. Measures for all three functional forms are presented in table 5[6].

TABLES 3-5 SOMEWHERE HERE

It is interesting to compare the results from the different specifications, but before going into that it should be noted that an LR-test (see table 4) clearly rejects both traditional specifications. The proposed specification exhibits (statistically significant) diseconomies of scale at firm level, and at the same time economies of scale at the branch level. The branch-level economies of scale are the greater (but insignificant), the more branches a firm has, since the fixed cost of the latest added branch are increasing in the number of branches. This can be seen in table 5 when comparing the two branch level economies of scale measures of the preferred model. Thus, the bigger is a firm's branch network, the stronger is the cost effect, and (probably) the smaller is the captivation effect. Smaller firms forego smaller economies of scale if they decide to open yet another branch, but they, too, experience average costs that are higher with an added branch than they would by expanding output at the existing branches. One possible explanation for the nature of the branch-level fixed costs comes from the vertical product differentiation literature (Shaked&Sutton 1983). It could be that it is optimal for the big firms to choose a strategy with high endogenous sunk costs (e.g. advertising). Another, related, explanation comes from the principal-agent literature. In Toivanen (1994b) it is shown that insurance firms with a branch network engage in vertical product differentiation, since a (bigger) branch network allows better screening of customer type and effort. There are overall, statistically significant, economies of scope, which are produced by the negative coefficient of the crossproduct term *XZ*. Economies of scope are stronger with a smaller number of branches. This effect is also due to the rise in fixed costs, when the branch network is expanded. When comparing these results to those achieved with the traditional functional forms, it is easy to see the difference. The traditional specification with no branch variable exhibits large, significant, economies of scale at the firm level compared with the preferred specification, and smaller economies of scope. It seems that the branch level economies of scale of the preferred model have been subsumed into the negative coefficient of the squared term *XX*, producing these results. Even the functional form with a linear branch term exhibits significant economies of scale at the firm level, as well as at the branch level. The scope estimate is closer to the traditional model I than to the preferred model. With this specification, as with the preferred one, branch level economies of scale increase with the number of branches.

The theoretically and statistically preferred functional form, where branches are treated as part of the output, gives results that, as suggested in the introduction, are possible due to the captivation and the cost effect, if fixed costs dominate variable ones. There are decreasing returns to scale in the Finnish non-life market, but this is not due to the production technology, but to the market characteristics that the firms face. Large geographical area, and a widely scattered, but locally dense population, and the oligopolistic, partly regulated structure of the industry underline the effects of the branch network in increasing the market power of the firms. The clear difference in results, when compared to the two more traditional specifications, should also be noted. These both would suggest that the industry is a natural monopoly, indeed one very near to a contestable market (in the case of the traditional model I, the results suggest a contestable market, and in the case of traditional model II, nearly so because the fixed costs of one branch, and more would be cost-inefficient, are close to zero) whereas the results of this study would point to the direction where a less concentrated structure would be more economical in cost terms.

The results of this study can be compared to those of Suret (1991) and Fecher et. al. (1992), which are to my knowledge the only non-life insurance studies using a flexible functional form (translog in both cases)[7]. Both studies report economies of scale. Suret, however, using Canadian data, only for a limited range of output. Suret reports no economies of scope, whereas Fecher et. al. use an aggregated output measure. Both studies use both premium income and claims as a measure of output. The results produced with premium income are biased, according to the theoretical model of section 2. In addition, Suret's study can have sample selection bias, as a few firms that do not produce all four lines of insurance are left out of the study. As the choice of product variety is the result of optimization, there must be a rational reason for these firms not to produce all lines of insurance.

On the basis of these results, both traditional models are rejected. They also produced very different qualitative results compared to the preferred model. It is possible that in a bigger market, say the U.S. banking market that has been the subject of several studies, the oligopolistic effects on cost functions are substantially weaker. This does not mean that they should not have been allowed for. The results of this study suggest that the traditional forms of cost function are likely to be misspecified, when used on data from a (oligopolistic) services industry.

To test the hypotheses that the traditional specifications result in too large inefficiency measures, these were calculated (using the procedure suggested by Jondrow et. al. 1982) and compared. The difference between the mean inefficiencies of both traditional models and the preferred model was positive and statistically significant, confirming the hypothesis (see table 6). To test whether this difference depends on the number of branches, as the theory suggests, I regressed it on production variables. The results are presented in table 6. They show that the difference is a decreasing function of branches, but an increasing function of the squared branches. For the difference between the preferred model and traditional model I (without branch variable), the difference is positive for all nonnegative values of the branch variable. For the difference between the preferred model and traditional model II, the difference turns positive at the level of 51 branches. The hypothesis that the difference is an increasing function of the number of branches thus gets support, albeit holding only above the threshold for traditional model II.

TABLE 6 SOMEWHERE HERE

As pointed out in the previous section, the preferred specification allows the investigation of the cost effects of the pursuit for market power through branch proliferation. As there are economies of scale at the branch level, the most cost effective way (abstracting from the transport costs of customers) would be to have just one branch per firm. Taking the geographic and populational facts into account, this would clearly be uneconomical. But if we assume that those firms (the five of the "big six") with an extensive branch network could let do with

a) the mean number of branches (rounded to the nearest integer): 22 or

b) the number of branches that the smallest of them has: 50 or

c) the number of branches that the firm of the other group with the most extensive branch network has, namely 34,

TABLE 7 SOMEWHERE HERE

then the extra costs can be calculated[8]. The results of these calculations, that are intended more to give a feel for the level of extra costs rather than being exact estimates are presented in table 7, where both the market total, and the firm-wise extra costs arising from branch proliferation are reported, as well as the percentage that these extra costs represent from the total operating costs[9] of the firms. These estimates underline the importance of the captivation effect: the big firms seem to forego substantial economies of scale in order to gain market power. Even the lowest average estimate indicates that 32% of the operating expenses are due to the captivation effect. Depending on which number of branches is taken as the yardstick, firm-wise estimates vary between 15 and 66%. Despite the crude character of these estimates, in my opinion it can be concluded that a nonnegligible part of the operating expenses of Finnish non-life insurance firms are due to the pursuit of market power.

5. Conclusions

This study rests on the observation that the relevant unit of production in services production is the branch. In most industries, establishing a branch means that at least some fixed costs have to be incurred, and, as a result, there are economies of scale over at least some range of output at the branch level. Depending on the characteristics of the production technology, these might even span over the entire output range. Despite this we can observe fairly dense branch networks in several services. In this paper, I argue that there are two off-setting forces that determine the size of the branch network. The captivation effect is the increase in market power that the firm acquires by expanding its branch network. The cost effect refers to the increase in (average) costs that this expansion results in. For a firm with a small branch network, the cost effect can be negative and the captivation effect is probably at its strongest, and thus that type of firms are likely to increase production through new branches. For big firms, the situation is reversed, and thus they are more likely to expand production by increasing it at the existing branches. The firms face different cost function at different levels of operation: the technical cost function at the branch level, and the perceived cost function at the firm level. The former is generated by the technology that the firms use, the latter is influenced not only by technology, but by market characteristics as well. For a multiproduct firm, branches can be viewed as one of the products, as customers prefer a firm for a combination of the products that it offers, and the location where these are offered. A branch network can create an externality, too, in that people prefer the otherwise similar product of a firm that has a large branch network to support the product.

The market power that is achieved by a big branch network is often best exploited by setting prices to a different level than smaller rivals. This means that in any service industry, turnover (or, for insurance, premium income) is a biased measure of output, and the correct measure is the number of products produced. The prominence of the branch network in the tool box of the firms means that it should not be left out of cost function estimations, but should be included in the same way as other products. Theory suggests to us that an industry can simultaneously have increasing returns to scale at branch level and decreasing returns to scale at firm level. If the actual production technology exhibits economies of scale, this should be observed at the branch level. It might then be, however, that the market characteristics are such that the profit-maximizing strategy is to increase the number of branches, even at the cost of foregoing potential economies of scale that the production technology exhibits.

The above theory was used in formulating a cost function, used to estimate the economies of scale and scope in the Finnish non-life insurance industry. The insurance industry has been comparatively neglected, and there are only a few published papers on non-life insurance that use modern econometric techniques. A technique was developed that allowed the estimation of a cost function on a limited set of data. The traditional functional forms were rejected. More importantly, they produced significantly different results. Whereas the preferred functional form confirmed the theoretical possibility of diseconomies of scale at firm level when there at the same time are economies of scale (although these were insignificant) at the branch level, and economies of scope, the traditional functional forms gave results according to which there would be significant economies of scale both at firm-and branch level. The economies of scope-results were similar for all specifications, although the preferred model produced the biggest values of the scope measure. The importance of these differences can be best understood in the light of the kind of guidance they would give to regulators. If one of the traditional functional forms were used, there would be little reason from the efficiency point of view for the regulator to grant new entry licences. The preferred results, however, show that small firms are more cost-efficient, and thus these results would give ground to opposite policy advice.

The hypotheses that traditional specifications lead to an upward biased inefficiency measure (too much inefficiency) and that this bias is positively related to the number of branches were both confirmed, although the latter was found to hold only above a certain threshold level with the other traditional specification. On basis of the econometric results of the cost function estimation, the cost effects of branch proliferation were calculated for those firms with a nationwide branch network. These proved to be of a very significant order, the lowest average measure that was obtained being 32%, when I assumed that the minimum number of branches needed is 50, corresponding to the size of the smallest nation-wide branch network of the "big six" firms. It seems thus that big firms, at least in the industry studied here, are prepared to sacrifice considerable gains from exploiting the production technology in order to gain market power.

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 introduced in a similar manner to other variables, 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 the more traditional functional forms are potentially misspecified, when applied to a service industry, and that branch proliferation might - and does - occur for other than efficiency reasons. Industrial economists have long known that an oligopoly does not minimize cost. This study shows, both theoretically and empirically, that oligopolistic firms do not necessarily do that either.

APPENDIX

Before going to the proofs of the propositions, let me state the profits and prices of firms *1* and *2* in the different possible geographical outcomes. The following notation is used:

α = density of customers in city *A*, $\alpha \geq 1$

p_i = price of firm i, $i = 1,2$

d = disutility parameter

t = transport cost between the cities

x = location in city *A*

y = location in city *B*

D_i = total demand of firm i

Π_i = profit of firm i

K = fixed cost of establishing a branch, $K > 0$

subscripts denote firms, superscripts the different locational outcomes

The following assumptions are made:

1. firm *1* is located at *0*

2. $d \leq t$

3. $\alpha \geq 1$

4. If the firms are indifferent with respect to geographical location, they locate in city *A*

5. In case of a tie, a firm chooses the smaller no. of branches

6. It is always profitable for both firms to establish at least one branch (they enter if expected profits are nonnegative

7. in case of ties, the firm prefers to locate in *A*

8. The reservation utility, homogenous over all customers, is low enough to guarantee full market coverage even for a monopoly with one branch

9. A firm has to set a uniform price (no intra-firm price discrimination)

10. The production process is homogenous over firms at branch level (ie. product differentiation in tastes does not affect the production costs)

11. marginal costs are zero

12. length of the taste line is 1

13. travel costs between the cities are linear, and quadratic on the taste line

The different outcomes are labelled as follows:

a) firm *1* in *A*, firm *2* in *B*

b) both firms in the same city, each having one branch (by ass. 4 in city *A*)

c) firm *1* in both cities, firm *2* in city *B*

d) firm *1* in both cities, firm *2* in city *A*

e) both firms in both cities

In cases a) and c), the demand in *A* is derived from

(1) $p_1 + dx^2 = p_2 + d(1-x)^2 + t$

giving

(2) $x = (p_2 - p_1 + d + t)/2d$

Demand in *B* is given by a similar equation to (1) in case a), by changing the subscripts and the location from x to y, giving

(3) $y = (p_1 - p_2 + d - t)/2d$

In case c), the demand for firms is the same as in the standard Hotelling model with quadratic transport costs, namely

(4) $y = (p_1 - p_2 + d)/2d$

The demands in case d) are derived similarly. In case b), the demands in the city where the firms are located is the normal Hotelling demand, similar to (4), and the demand from the city with no branches is for firm *1* is again similar to (4), since transport costs are the same to either firm and do thus not affect their respective demands (and, remember, it is assumed that the market is covered).

From the above, the demands, prices and profits can be derived. They are, for each case, as follows:

a) (1a) $D_1^a = (\alpha + 1)/2 + t(\alpha - 1)]/6$

(2a) $D_2^a = (\alpha + 1)/2 + t(\alpha - 1)]/6$

(3a) $p_1^a = d + t(\alpha - 1)/3(1 + \alpha)$

(4a) $p_2^a = d - t(\alpha - 1)/3(1 + \alpha)$ $p_2 > 0$ by ass. 2 and 3

(5a) $\Pi_1^a = d(\alpha + 1)/2 + t(\alpha - 1)/6 + t^2(\alpha - 1)^2/[18d(1 + \alpha)] - K$

(6a) $\Pi_2^a = d(\alpha + 1)/2 - t(\alpha - 1)/6 + t^2(\alpha - 1)^2/[18d(1 + \alpha)] - K$

b) (1b) $D_i^b = (\alpha + 1)/2$ $i = 1,2$

(2b) $p_i^b = d/2$ $i = 1,2$

(3b) $\Pi_i^b = d(\alpha + 1)/4 - K \quad i = 1,2$

c) (1c) $D_1^c = (\alpha + 1)/2 + \alpha t/6d$

(2c) $D_2^c = (\alpha + 1)/2 - \alpha t/6d$

(3c) $p_1^c = d + \alpha t/3(\alpha + 1)$

(4c) $p_2^c = d - \alpha t/3(\alpha + 1)$

(5c) $\Pi_1^c = d(\alpha + 1)/2 + \alpha t/3 + (\alpha t)^2/[18d(\alpha + 1)] - 2K$

(6c) $\Pi_2^c = d(\alpha + 1)/2 - \alpha t/3 + (\alpha t)^2/[18d(\alpha + 1)] - K$

d) (1d) $D_1^d = (\alpha + 1)/2 + t/6d$

(2d) $D_2^d = (\alpha + 1)/2 - t/6d$

(3d) $p_1^d = d + t/3(\alpha + 1)$

(4d) $p_2^d = d - t/3(\alpha + 1)$

(5d) $\Pi_1^d = d(\alpha + 1)/2 + t/3 + t^2/[18d(\alpha + 1)] - 2K$

(6d) $\Pi_2^d = d(\alpha + 1)/2 - t/3 + t^2/[18d(\alpha + 1)] - K$

e) (1e) $D_i^b = (\alpha + 1)/4 \quad i = 1,2$

(2e) $p_i^b = d/2 \quad i = 1,2$

(3e) $\Pi_i^b = d(\alpha + 1)/4 - 2K \quad i = 1,2$

Here, superscripts denote cases (*a,..,e*) and subscripts denote firms. In the following, the propositions are restated and their proofs are given. I also state the conditions under which each branch network configuration is a subgame perfect Nash equilibrium.

proposition 2: if it is not profitable for either firm to open more than one branch, then the firms will choose different locations, and firm *1* will open its branch in the bigger city *A*.

proof: To prove this proposition, it has to be shown that if the branches of the firms are in different cities, the profits of the firm in city *A* are higher than those of its rival. This follows from eq. *(1a) - (4a)*. Inspecting these it is easy to see that both the demand and price of firm *1* (which is assumed to have a branch in city *A*) are higher than its rival's, and thus also profits. The second part - that firm *2* locates in city *B* - can be proved by calculating the difference in profits that firm *2* gets in locating in either city

$\Pi_2^a - \Pi_2^b = [3d + 2t + \alpha(3d-2t)]/12 + t^2(\alpha - 1)^2/[18d(\alpha +1)] > 0$

For this to be an equilibrium, it must be unprofitable for either firm to open a second branch. This is the case if the following relationship holds:

$$\Pi_1^a - \Pi_1^c = K - t(\alpha + 1)/6 + t^2(1 - 2\alpha)/[18d(\alpha + 1)] \geq 0$$

This holds for small enough t and α and large enough d and K. The relationship says that it must be unprofitable for firm *1* to open a new branch even if firm *2*'s first branch is located in city *B*, a situation that gives a two-branch firm *1* larger profits than a situation where firm *2*'s only branch is in city *A*. The weak inequality sign follows from assumption 5.

Q.E.D.

proposition 3: If the optimal number of branches per firm is 1, then firm *1* (located in *A*) sets a higher price and has a higher demand.

proof: by inspecting equations *(1a)* - *(4a)* Q.E.D.

proposition 4: If it is profitable for just one firm (firm *1*) to open two branches, then its rival will open its branch in city *A*. Firm *1* will set a higher price, and have a higher demand than its rival.

proof: the firm with two branches will be firm *1*. The profits of firm 2 if its only branch is in city *A* and *B* are, respectively, given by equations *(6c)* and *(6d)*. It is easy to see that the former is at least as large as the latter. For this to be an equilibrium, firm *1*'s profits have to grow when opening a second branch, and firm 2 must find it unprofitable to open a second branch. The following two relationships must hold:

$$\Pi_1^d - \Pi_1^a = t(3 - \alpha)/6 + \alpha(2 - \alpha)t^2/[18d(\alpha + 1)] - K \geq 0$$

$$\Pi_2^d - \Pi_2^e = (\alpha + 1)/4 - t/3 + t^2/[18d(\alpha + 1)] + K \geq 0$$

Let the first hold by equality, solve for K and insert into the second equation. It is easy to see that for small enough values of α,d and t, the latter holds.

Q.E.D.

proposition 5: If firm *1*'s profits are higher with two branches than with one given that firm 2 has just one branch (and then the same applies to firm 2), and if firm 2's profits are higher with two branches than with one given the number of firm *1*'s branches, then the equilibrium number of branches is two for both firms. The profits are, however, lower compared to a situation where both firms would have just one branch. For this to be an equilibrium, the following two relationships have to hold:

$$\Pi_1^d - \Pi_1^a = t(3 - \alpha)/6 + \alpha(2 - \alpha)t^2/[18d(\alpha + 1)] - K > 0$$

$$\Pi_2^e - \Pi_2^d = t/3 - t^2[18d(\alpha + 1)] - (\alpha + 1)/4 - K > 0$$

Let the latter hold with equality, solve for K and insert into the former. Then it is easy to see that the former holds for small enough α. Both inequalities are strong because of assumption 5. Q.E.D.

proposition 6: An oligopolistic firm that maximizes profits does not necessarily minimize costs.

proof: In the proofs for propositions 4 and 5 it was shown that for given parameter values, there can be either an asymmetric branch network equilibrium where firm *1* has two branches, or a symmetric one with both firms having two branches. As pointed out in the text, this branch proliferation leads to an increase in average costs through a duplication of fixed costs because the (possible) gain in market share is not large enough (the rise in market share is zero for both firms in case of the symmetric equilibrium and less than 100% for firm *1* in the asymmetric equilibrium) to compensate for the rise in costs. Q.E.D.

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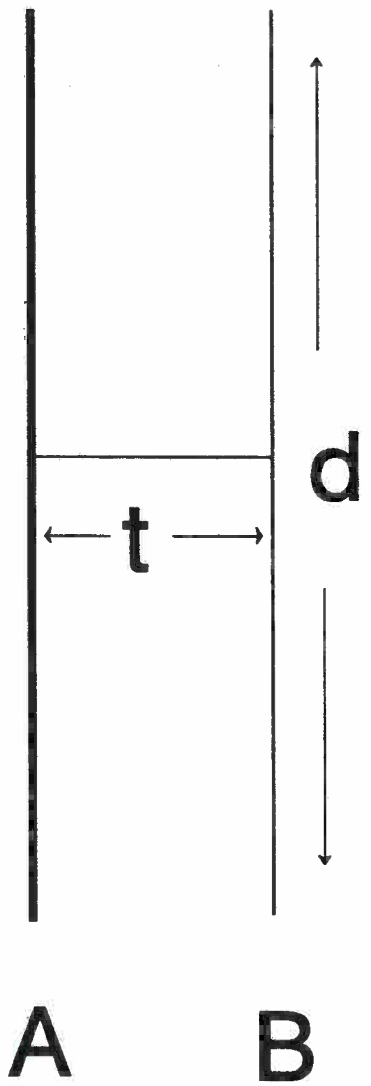
figure 1



LINES OF INSURANCE IN THE FINNISH NON-LIFE INSURANCE MARKET (1991 DATA)

General category/subcategory	no. of firms	premium income (1000 FIM)	% of total	CR4
Statutory accident ins.				
general tariffs*	13	876 623	7.8	83.9
special tariffs*	13	1 156 707	10.3	88.1
ins. against other accidents	13	60 958	0.5	83.1
Other accident ins.				
continuous individual	14	338 930	3.0	68.4
cont. group ins.	13	108 581	0.9	91.2
traveller's ins. etc.	15	186 424	1.7	92.9
other ins.	12	13 387	0.0	87.6
Compulsory motor third party liability ins.	13	2 481 157	22.1	73.1
Motor vehicle ins.	16	1 676 160	14.9	80.0
Hull ins.				
ship hull, civil	9	141 645	1.3	89.8
ship hull, war	5	6 995	0.1	99.6
protection and indemnity liability	1	1 521	0.0	100.0
yacht ins.	14	71 931	0.6	75.5
aircraft hull ins.	8	9 177	0.1	97.9
aviation liability	6	4 034	0.0	99.5
Cargo ins.**	18	339 271	3.0	84.4
Fire and other combined property ins.				
households' fire ins.	13	57 071	0.1	63.3
households' compr. house etc. ins.	15	1 155 460	10.3	76.2
farm ins.	13	174 619	1.6	84.5
other ins.	4	165	0.0	100.0
industrial fire	15	287 783	2.6	86.8
trading fire	12	26 636	0.0	91.9
other fire ins.	11	69 689	0.1	93.4
real estate ins.	17	421 673	3.8	81.5
combined ins. (industrial)	11	188 278	1.7	70.8
combined ins. (trade)	12	111 411	1.0	93.3
combined ins. (other)	10	107 281	1.0	89.1
burglary and robbery ins.	12	24 163	0.2	91.2
water damage ins.	11	8 989	0.0	95.1
glass and shield ins.	10	3 830	0.0	88.5
machinery breakdown ins.	9	64 175	0.6	82.2
other ins.	5	16 562	0.1	100.0
Loss of profit ins.	7	175 832	1.6	96.0
Forest ins.	13	32 360	0.3	85.8
Third party ins.	18	327 049	2.9	84.1
Credit ins.	18	317 577	2.8	71.0
Other ins.	19	160 231	1.4	92.9
Finnish reins.***	32	932 880		
Foreign ins.***	13	1 611 887		

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 is based on the output measure used, usually the no. of contracts
* measure of output working time in Mio. working hours
** measure of output no. of accidents
*** measure of output premium income. These lines can be viewed as part of the international market, where market power of Finnish firms is bound to be low

Table 1

KEY INFORMATION ON FIRMS IN THE FINNISH NON-LIFE INSURANCE MARKET

no. of firms in the market	21
highest number of branches	107
lowest number of branches	1
mean number of branches	22
no. of firms with one branch	10
average premium income (direct ins.)	509 000 000 FIM

table 2

DESCRIPTIVE STATISTICS OF ESTIMATION VARIABLES

Variable	Mean	Standard error
operating costs	108 560.4	167 358.3
X	601 110.0	980 610.0
XX	166 720 000 000.0	363 170 000 000.0
XZ	370 820 000 000.0	877 350 000 000.0
K	22.6	31.6
KK	1492.6	2913.8
XK	103 950 000 000 000.0	481 690 000 000 000.0

operating costs = salaries + other social expenses + other operating expenses in 1991 money

$X = \sum p_i x_i \quad i = 1,\ldots,39$

$XX = \sum (p_i x_i)^2$

$XZ = \sum p_i p_j x_i x_j \quad i \neq j$

K = no. of branches in 1989

$KK = K^2$

$XK = \sum p_i x_i k$

table 3

ESTIMATION RESULTS FOR THE QUADRATIC COST FUNCTION			
variable	pref. specification	traditional spec. I	traditional spec. II
const.	-10620 (11060)	-23073 (16680)	-29184** (14790)
X	0.18475*** (0.02956)	0.32569*** (0.02689)	0.24535*** (0.05677)
XX	0.38E-07 (0.66E-07)	-0.41E-06*** (0.41E-07)	-0.31E-06*** (0.76E-07)
XZ	-0.16E-06*** (0.22E-07)	-0.95E-08 (0.23E-07)	-0.13E-07 (0.19E-07)
K	-753.21 (585.2)		1474.2*** (795.1)
KK	48.018*** (9.154)		
XK	0.37E-11 (0.17E-10)		
$\sigma(u)/\sigma(v)$	2.5011 (1.910)	2.0186** (0.8469)	3.7356 (2.903)
$[\sigma^2(u)+\sigma^2(v)]^{1/2}$	36940*** (6057)	51074*** (11070)	49903*** (6938)
logL	-726.92	-751.09	-744.22
LR-test (d.f)		48.52*** (3)	34.77*** (1)

LR-test = LR-test against the preferred specification; degrees of freedom in parentheses
* = significant at the 10% level
** = significant at the 5% level
*** = significant at the 1% level
numbers in parentheses are standard errors

table 4

ESTIMATES OF ECONOMIES OF SCALE AND SCOPE			
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***

S_N = economies of scale: significance = sign. different from unity
S_E = economies of scope: significance = sign. different 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 (=22)
* = significant at the 10% level
** = significant at the 5% level
*** = significant at the 1% level

table 5

ESTIMATES OF THE DIFFERENCE IN INEFFICIENCY MEASURES (PREFERRED MODEL VS. TRAD. MODEL I)		
variable	preferred spec. vs. trad. model I	preferred spec. vs. trad. model II
constant	118557*** (1268)	17516*** (1199)
X	-0.075*** (0.047)	-0.056*** (0.004)
XX	0.29E-06*** (0.13E-07)	0.31E-06*** (0.12E-07)
K	-852.19*** (88.44)	-1911.9*** (83.69)
KK	33.337*** (1.345)	42.496*** (1.273)
XK	0.22E-11 (0.13E-11)	0.26E-11*** (0.13E-12)
XY	-0.11E-06*** (0.13E-08)	-0.13E-06*** (0.44E-08)
R^2	0.938	0.958
F-test	101.672***	153.576***
t-test that the means of the LHS variable is different from zero	2.92***	2.47***

* = significant at the 10% level ** = significant at the 5% level
*** = significant at the 1% level
numbers in parentheses are standard errors
LHS variable: the difference in firm- and period wise inefficiency measures of the models under comparison

table 6

ESTIMATES OF THE COST OF BRANCH PROLIFERATION						
Firm ranking (size)	no. of branches	total operating costs (1991, 1000 FIM)	ψK + ρKK with existing no. branches (1 000 FIM)	difference to ψK + ρKK with mean no. of branches (22)	difference to ψK + ρKK with min. of big firms' branches (50)	difference to ψK + ρKK with max. of small firms' branches (34)
1st	107	705 034	469 164	462 495 (66%)	386 780 (55%)	439 265 (62%)
2nd	83	591 519	268 280	261 610 (44%)	185 895 (31%)	238 380 (40%)
3rd	67	302 548	165 088	158 418 (52%)	82 703 (27%)	135 188 (45%)
4th	63	268 733	143 131	136 461 (51%)	60 747 (22%)	113 232 (42%)
5th	50	360 184	82 385	75 714 (21%)	0 (0%)	52 485 (15%)
Σ				1 094 697 (49%)	716 125 (32%)	978 549 (44%)

numbers in parentheses in columns 3-6 are per cents of total operating expenses

table 7

FOOTNOTES:

1. For a regional economics approach, see Stahl (1987).

2. All other data but the number of branches is from Statistics Finland: Insurance. The number of branches per firm was kindly collected by the research dept. of the Association of Finnish Insurers, whose help is thankfully recognized.

3. CR4 is calculated as the percentage of the number of policies sold that the four biggest firms in each line of insurance produce.

4. There are two main reasons for this: some firms, primarily industry captives that are really not active according to industry sources, have been excluded and the subsidiaries of firms have been merged into their parents. One firm was excluded because it was active only in one period and because its parent, a life insurance firm, went into receivership shortly after the observation period. Its market share was negligible, however.

5. $v(i)$ was assumed to be half-normally distributed.

6. In the calculations for the measures of economies of scale and scope, all coefficients were included, and the standard errors were calculated accordingly.

7. For a summary of earlier insurance studies using other functional forms, see Suret.

8. In producing this table, the coefficients of both K and KK were used even if the latter was insignificant. Estimates using only the coefficient of K would be 2-9 percentage points higher.

9. I have used estimated total costs in the calculations. This does not affect the results, as the average difference to the estimated percentage share of branch proliferation from total costs, when true total costs are used, is less than 1 percentage point.