

An Examination of Cost Economies in the United States Life Insurance Industry

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ABSTRACT

Using an industry sample of 423 U.S. life insurers, this study reports estimates of overall and product specific scale economies, as well as, pair-wise cost complementarities for a wide variety of products. Estimates of these cost characteristics are provided for numerous output vectors since theory suggests that the magnitude of scale economies and cost complementarities may vary with the scale and mix of outputs. In contrast, previous studies only provide a single point estimate of industry cost characteristics using the sample mean output vector. This study, therefore, provides a more complete representation of the industry's cost characteristic and, in turn, new insights into decisions related to the optimal scale and mix of outputs.

Potential cost savings arising from economies of scale and scope in the life insurance industry are important to both firm managers and regulators. The potential for economies of scale and scope affects managerial decisions regarding the scale and mix of outputs. Substantial cost economies may result in a highly concentrated industry that would facilitate collusive pricing behavior. In a multiproduct industry, however, a concentrated market structure may only be one of many possible equilibria. Another equilibrium may entail a large number of firms producing only a small range and scale of outputs. In either case, regulators would be interested in the existence of cost economies and their effects on market structure.¹

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¹ With multiproduct production, a unique market equilibrium, if one exist depends on the magnitude of cost economies and the structure of consumer demand. The literature on multiproduct firms and market structure has emerged only recently (e.g., see Shaked and Sutton (1990)).

Early studies of the life insurance industry limit their analysis to the estimation of single-product scale economies (e.g., see Geehan, 1986, for a review of studies using a single output measure). These studies' methodologies do not explicitly incorporate the multiproduct nature of most life insurance firms, and estimates of scale economies are provided for only the sample mean level of output. More recent studies (e.g., Fields, 1988, Fields and Murphy, 1989, and Kellner and Mathewson, 1983) use a multiproduct methodology to derive estimates of economies of scale and scope for the industry sample mean vector of outputs. Economic theory, however, suggests that the magnitude of cost economies varies with the scale and mix of outputs. Hence, previous studies' estimates of cost economies which are derived solely from the sample mean vector of outputs provide only limited insights into the cost characteristics of firms away from the sample mean firm. A thorough analysis of the cost structure of the life insurance industry, therefore, requires estimates of cost economies for firms varying in both the scale and mix of outputs. Such an analysis is essential to the study of the life insurance industry since the industry is comprised of many firms exhibiting substantial variation in the scale of outputs and the range of product offerings.

Using a multiproduct cost function and an industry sample of 423 U.S. life insurers this study reports estimates of overall and product-specific scale economies as well as pair-wise cost complementarities for a wide variety of products. Estimates of these cost characteristics are provided for a number of output vectors varying in the scale and mix of outputs, organizational form (stock versus mutual), and production/distribution structure (agency versus non-agency). This study, therefore, provides a more complete representation of the industry's cost structure than previous studies.

The results show increasing overall scale economies for all but the largest agency firms which display approximately constant returns to scale. Significant increasing product specific scale economies are found for accident and health and investments products for all companies, and ordinary life for agency companies. The results do not support the hypothesis of cost complementarities being the *raison d'etre* for multiproduct production among life insurers. Regarding the effects of organizational form, mutuals are not shown to incur higher costs than stock companies for a given scale and mix of outputs. This finding is not consistent with the hypothesis that the principal-agent conflict, e.g. expense preference behavior by managers, is greater for mutuals than for stock companies (see Fama and Jensen, 1983, Fields, 1988, and Mayers and Smith, 1988). Finally, the results suggest that agency firms generally exhibit lower scale economies than non-agency firms which is consistent with the existence of greater scale economies in the production of products than in the distribution of the same products.

The article is organized as follows. An introduction to multiproduct cost characteristics is presented next. Then the methodology and data are

described. Empirical results and their implications are followed by conclusions.

Multiproduct Technologies

Cost subadditivity implies cost savings from one firm producing a set of products or a larger scale of outputs as compared to the costs of separate firms producing a separate line or smaller quantities of several products (Baumol, Panzar, and Willig, 1982). Symbolically, cost subadditivity can be expressed as

$$C(Q^B) < \sum_i C(Q^i) \quad (1)$$

where $C(\cdot)$ is a cost function, Q 's are output vectors, and $Q^B = \sum_i Q^i$. In Equation (1), the Q^i output vectors must have non-negative elements and non-zero elements for at least two of the Q^i . "Global" cost subadditivity is said to exist if the condition in Equation (1) holds for all points along the cost manifold.² If Equation (1) holds for all points along the cost manifold, a natural monopoly exists (see Sharkey, 1982).

Ray Scale Economies

Insights into the existence of subadditive costs are provided by examining measures of overall and product specific scale economies. Overall scale economies is a measure of total output cost elasticity as a firm expands outputs along an output ray emanating from the origin, holding output mix constant (e.g., movement from Q^B on the output ray OX in Figure 1(a)). Scale economies for a given vector of outputs (e.g. Q^B on OX in Figure 1(a)) is commonly measured by ray scale economies (RSCE) which are defined as

$$RSCE^B = \sum_i \partial \ln C(Q^B) / \partial \ln q_i = \sum_i \varepsilon_i \quad (2)$$

where q_i is the quantity of output for the i th product and $\varepsilon_i = \partial \ln C(Q^B) / \partial \ln q_i$. If $RSCE^B$ is equal to (is greater than) (is less than) 1, production of this vector of outputs exhibits constant (decreasing) (increasing) returns to scale.

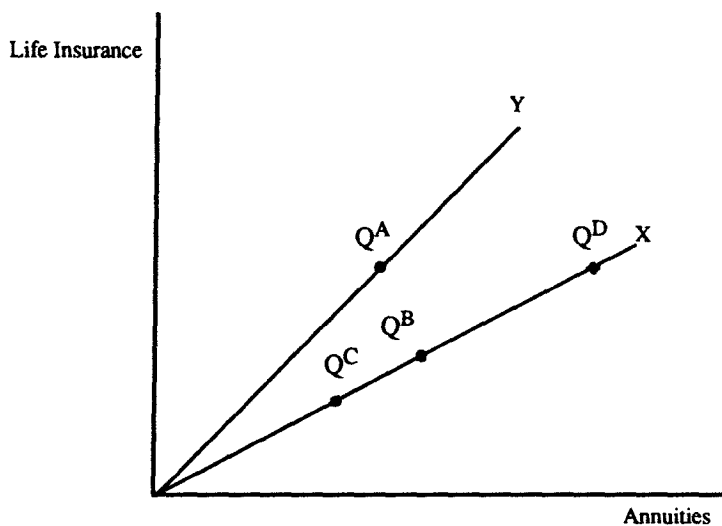
Product-Specific Scale Economies

Further insights into cost subadditivity are provided by examining product specific scale economies. Increasing product specific scale economies imply declining marginal costs. Product specific scale economies for output q_i at Q^B are defined as:

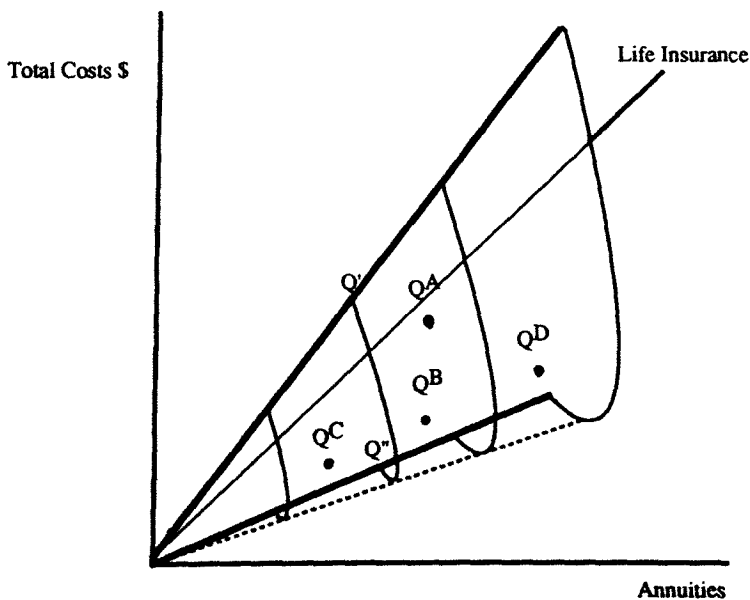
$$PSSCE_i^B = \partial^2 C(Q^B) / \partial q_i^2 \quad (3)$$

² Cost are superadditive if $C(Q^B) > \sum_i C(Q^i)$ and additive if $C(Q^B) = \sum_i C(Q^i)$.

Figure 1
Graphical Representation of a Multiproduct Firm's Cost Characteristics



(a) A Multiproduct Insurance Firm's Output Rays



(b) A Multiproduct Insurance Firm's Cost Manifold

Marginal costs are decreasing if $PSSCE < 0$, implying product specific increasing returns to scale. Conversely, $PSSCE > 0$ is associated with increasing marginal costs and product specific decreasing returns to scale, whereas $PSSCE = 0$ implies constant marginal costs.

Pair-wise Cost Complementarities

Additional insights into the existence of cost subadditivity are provided by examining pair-wise cost complementarities between outputs. Cost complementarities exist when joint production lowers aggregate costs. A stylized example of pair-wise cost complementarities for life insurance and annuities is shown in Figure 1(b). As the firm changes from the sole production of life insurance or annuities to the production of both outputs along the transray $Q'Q''$, aggregate costs are reduced. An estimate of the cost complementarity between the pair of outputs i and j " $CC_{i,j}^B$ " for the output vector Q^B is defined as:

$$CC_{i,j}^B = \Sigma_i \partial^2 C(Q^B) / \partial q_i \partial q_j. \quad (4)$$

Cost complementarities imply economies of scope if $CC_{i,j} < 0$. Diseconomies of scope are indicated by $CC_{i,j} > 0$, whereas $CC_{i,j} = 0$ is consistent with the existence of additive costs.³

Limitations of Scale Economies and Cost Complementarity Measures

The scale economies measures $RSCE^B$ in Equation (2) and $PSSCE_i^B$ in Equation (3), and the cost complementarity measure $CC_{i,j}^B$ in Equation (4), are conditional upon both the scale and mix of outputs in Q^B . Hence, measures of cost characteristics derived for Q^B on OX in Figure 1(a) may provide only limited insights into the cost characteristics of Q^A on OY , which is comprised of a different mix of products, although both vectors contain the same aggregate scale of outputs. In addition, along a given output ray cost characteristics can also change (e.g., scale economies may differ for Q^D and Q^B although both lie on the output ray OX). A complete analysis of an industry's cost manifold, as shown in Figure 1 (b), requires, therefore, measures of $RSCE$, $PSSCE$, and $CC_{i,j}$ be estimated for output bundles differing in scale along a given output ray (e.g. Q^B , Q^C , and Q^D on OX in Figure 1(a)) and differing product mix (e.g. Q^B on OX , and Q^A on OY).

³ There are, however, caveats associated with the Denny and Fuss (1977) and Denny and Pinto (1978) approach to examining scope economies, and in turn, cost subadditivity. One problem relates to the sufficient condition for the existence of scope economies, that is, $CC_{i,j} \leq 0$ must hold for all pair-wise output combinations and must hold with strict inequality for at least one pair of outputs. For cases where the number of outputs exceeds two, these conditions are very restrictive and the estimates of $CC_{i,j}$ can often give inconclusive results. That is, some pair-wise combinations are complementary and others are non-complementary.

An analysis of numerous output vectors provides important information on the life insurance industry's cost structure since the industry is characterized by many firms which differ by scale and mix of outputs. Previous multiproduct studies of the life insurance industry (e.g., Fields, 1988, Fields and Murphy, 1989, Kellner and Mathewson, 1983) only provide point estimates at the mean value of outputs for the overall sample. The existence of increasing ray scale economies and economies of scope at the sample mean of outputs is a necessary, but not sufficient condition, for the existence of "global" subadditivity (i.e., the condition in Equation (1) holds for all points along the industry's cost manifold). In addition, the cost characteristics measured at the sample mean may provide only limited insights into what Evans and Heckman (1984) call "quasi-global" cost subadditivity.

Evans and Heckman (1984) (see also Evans and Heckman, 1986 and Sueyoshi and Anselmo, 1986) define the concept of quasi-global cost subadditivity as the subadditivity condition expressed in Equation (1) holding within an "admissible region" of output.⁴ For example, the admissible region could be specified as the scale of outputs of the largest firms in the industry. The cost characteristics of the largest firm in the industry maybe of interest with regards to regulation limiting market concentration associated with mergers and acquisitions. In this case, regulators may have to weigh the benefits of lower unit production costs, arising from larger firms' ability to fully exploit cost economies, against the possible adverse impact on competition resulting from a more concentrated market. As another example, the admissible region of output may at times be defined as the outputs of smaller firms which may produce less than the mean sized firm in an industry sample. Special interest in smaller firms may arise if, for example, it is believed that cost structure affects a firms' financial viability and smaller firms failure to fully exploit cost economies impairs their financial integrity. In both examples, knowledge of the cost structure at points away from the industry sample mean should provide useful insights for regulators.⁵ However, statistical analysis of a sample of

⁴ See Hunter, Timme, and Yang (1990) for tests of quasi-global cost subadditivity in the commercial banking industry.

⁵ Regulators may also be interested in the cost characteristics of specific admissible regions if technological change and the scale and mix of outputs are interrelated. The hypothesis relating technological change to firm size was first set forth by Joseph Schumpeter (1942) and elaborated by John Kenneth Galbraith (1952). The Galbraith-Schumpeter hypothesis states that the optimal size firm is related to the degree of scale economies in the process of generating and implementing new technologies. According to the Galbraith-Schumpeter view, larger firms are better able to develop and adopt technologically superior equipment and processes and adapt more readily to external changes in order to reduce costs. Hence, public policy emphasizing the regulation of market concentration loses much of its rationale to the extent that consumers benefit from technological advantages of firms. The negative aspect of the Galbraith-Schumpeter hypothesis concerns the long-run possibility that larger firms, since they enjoy faster rates of innovation, will possibly develop excessive market power to the detriment

only large or small firms would be undesirable since the exclusion of other size firms would likely result in the loss of information.

Fortunately, the formulations of RSCE, PSSCE, and CC_{ij} in Equations (2), (3), and (4), respectively, permit estimates of scale economies and cost complementarities for various output vectors along the overall cost manifold. Analysis of ray scale economies and cost complementarities at various points along the cost manifold should, therefore, provide richer insights into the possible existence of global and quasi-global cost subadditivity. For example, costs may be additive when evaluated at the sample mean vector of outputs. However, costs could be subadditive or superadditive when evaluated at points along the cost manifold that are either below or above the sample mean output vector.

Model Specification and Data

Model

A second-order hybrid translog approximation (e.g., see Caves, Christensen and Trethway, 1980) to a multiproduct total cost function is used to derive estimates of scale economies and cost complementarities at various points along the sample cost manifold. In the hybrid translog, the dependent variable is the natural log of total costs and the independent variables are outputs transformed using the Box-Cox metric and the natural log of factor input prices. Unlike the conventional translog, the hybrid translog allows for zero outputs, since outputs are transformed using the Box-Cox metric. The transformed value of the output q_i using the Box-Cox metric is

$$Q_i = (q_i^\lambda - 1)/\lambda. \quad (5)$$

In Equation (5), if $q_i = 0$, $Q_i = (-1/\lambda)$. In addition, for $\lambda \rightarrow 0$, $Q_i = \ln q_i$. Hence, the conventional translog is a special case of the hybrid translog. The hybrid translog is well suited for the study of the life insurance industry since the industry is comprised of some firms specializing in only a few product lines and other firms which offer a wide variety of products.

The second-order hybrid translog approximation used in this study is written as

$$\begin{aligned} \ln C = & \alpha_0 + \sum_m \alpha_m \ln P_m + \frac{1}{2} \sum_m \sum_n \alpha_{m,n} \ln P_m \ln P_n + \sum_i \beta_i Q_i \\ & + \frac{1}{2} \sum_i \sum_j \beta_{i,j} Q_i Q_j + \sum_i \sum_m \Phi_{i,m} Q_i \ln P_m \\ & + \theta_M D_M + \sum_m \theta_{M,m} D_M \ln P_m + \sum_i \theta_{M,i} D_M Q_i \\ & + \theta_A D_A + \sum_m \theta_{A,m} D_A \ln P_m + \sum_i \theta_{A,i} D_A Q_i + \eta \end{aligned} \quad (6)$$

$m, n = L \text{ and } K, \text{ and}$
 $i, j = \text{INV, OL, GL, OA, GA and A\&H,}$

where $Q_i = (q_i^\lambda - 1)/\lambda$ from Equation (5), C = total costs, q_{INV} = dollar volume of security investments, q_{OL} = dollar amount of ordinary life insurance premiums, q_{GL} = dollar amount of group life insurance premiums, q_{OA} = dollar amount of ordinary annuity considerations, q_{GA} = dollar amount of group annuity considerations, $q_{A\&H}$ = dollar amount of accident and health premiums, P_L = price of labor, P_K = price of capital, D_M = dummy variable equal to 1 if a mutual company, and 0 otherwise, D_A = dummy variable equal to 1 if an agency and 0 otherwise, and η = random error term. In estimating Equation (6), the usual symmetry constraints ($\alpha_{m,n} = \alpha_{n,m}$ and $\beta_{i,j} = \beta_{j,i}$) and homogeneity and adding-up ($\sum_m \alpha_m = 1$ and $\sum_m \alpha_{m,n} = \sum_m \Phi_{i,m} = \sum_m \theta_{M,m} = \sum_m \theta_{A,m} = 0$) are imposed.⁶

The agency/non-agency dummy variable is included to account for possible differences in cost structures resulting from the production (non-agency) as opposed to the production and distribution (agency) of insurance products (e.g., see Fields and Murphy, 1989).⁷ The mutual/stock dummy variable is included in Equation (6) to account for possible differences in cost structures resulting, for example, from differences in the extent of the principal-agent problem in mutual and stock companies (e.g., see Fama and Jensen, 1983, Fields, 1988, and Mayers and Smith, 1988).

The Definition of Output

Difficulties associated with the definition of output and the appropriate level of aggregation of outputs are encountered in all insurance cost studies. Geehan (1986), for example, provides a useful discussion of the issues involved and presents a comparison of major studies using different output measures. In this study, a definition of output based upon premiums and annuity considerations is employed. This is consistent with the approach used by numerous authors (e.g., see Joskow, 1973, Blair, Jackson, and Vogel, 1975, and Weiss, 1986). In addition, the dollar value of investments is also defined as an output. Including investments is appropriate for life insurers since they represent a major activity for most firms. It is also consistent with various previous cost studies of financial intermediaries (e.g., see Gilligan, Smirlock and Marshall, 1984, and Mester, 1987).

Regarding aggregation, the choice of six output measures, q_{INV} , q_{OL} , q_{GL} , q_{OA} , q_{GA} , and $q_{A\&H}$, is tempered by the objective of examining multiproduct cost attributes within an econometrically tractable model of the insurance firm. Hence, a maintained hypothesis is that for a given output category, a

⁶ In addition, other maintained hypotheses are that all insurers are cost minimizers who have access to the same level of technology and exhibit the same level of risk; output is exogenous; and input markets are competitive.

⁷ Firms were classified based on their representation in *Best's Reports* (Life/Health ed.) for 1987. If more than one marketing function was given, the first one was presumed to be the correct one for classification purposes. If no marketing organization was given, then the firm was dropped from the sample.

single cost function adequately characterizes the production of each of the activities aggregated within that category.

The Data

The data are from the National Association of Insurance Commissioners (NAIC) tapes of the life insurance annual reports for the year 1987. The particular data subset employed contains information from Form 1 (Analysis of Operations by Lines of Business), Exhibit 1-Part 1 (Premiums and Annuity Considerations), Exhibit 2-3 (Investment Income), Exhibit 5 (General Expenses), and Exhibit 13 (Assets).

Total cost, C , includes labor, capital, and miscellaneous expenses. Labor expenses are comprised of commissions on premiums and annuity considerations (direct business only) and the sum of salaries, wages, and benefits. Capital expenses equal the sum of the rental cost of buildings and equipment, and depreciation on furniture and equipment.⁸ Miscellaneous expenses include items such as legal and accounting fees, travel, advertising, and all other non-labor and non-capital expenses, but exclude taxes. The price of labor for each insurer equals the average salary for financial services employees for each state reported by the Bureau of Labor Statistics weighted by the percent of total output, excluding securities, accounted for by each state. The price of capital equals capital expenses divided by the value of capital assets. It is a maintained hypothesis that the prices of miscellaneous items are invariant across all firms and therefore, are not included in cost Equation (6).

The investment output, q_{INV} , is the firm's investment in bonds, stocks and real estate. The life insurance outputs, q_{OL} and q_{GL} , equal the sum of net premiums collected (direct + assumed - ceded) for ordinary and group life insurance, respectively. Annuity outputs, q_{OA} and q_{GA} , equal the sum of considerations for ordinary and group annuities, respectively. Included in the definition of life and annuity outputs are the premiums for all life and annuity products. Finally, accident and health, $q_{A\&H}$, equals the sum of collected premiums.⁹

Data were collected for the top 500 life insurers ranked by the output metric $(q_{OL} + q_{GL} + q_{OA} + q_{GA} + q_{A\&H})$. Companies with incomplete data

⁸ As pointed out by a referee, the definition of capital expenses used in this study understates total capital costs since insurers are required to hold an "adequate" amount of surplus to provide assurance the insurer will be able to pay benefits even if losses are higher than anticipated. Hence, the paper's results should be interpreted within the limitations of the data.

⁹ Premiums have been commonly used in previous cost studies. However, as noted by a referee a caveat to the use of premiums is that they are affected by factors other than economies of scale and scope. For example, "riskier" insurers would be expected to charge lower premiums whereas Doherty (1981) argues that large firms can charge higher premiums. The combined effects of these other on the paper's results are unknown. For example, if the advantage of being larger is offset by higher risk, than the paper's results may be unaffected. On the other hand, if larger firms are also less risky, than the results will overstate true cost economies. Caution should be exhibited, therefore, in the interpretation of the paper's results.

were excluded. The final sample consists of 423 firms. Summary statistics for the sample data are presented in Table 1. Table 1 also contains summary statistics for subgroups based on legal organizational form (stock vs. mutual) and production/distribution structure (agency vs. non-agency). Table 1 also reports the percentage of life, annuity and accident and health outputs by category relative to the output metric ($q_{OL} + q_{GL} + q_{OA} + q_{GA} + q_{A\&H}$).

Since data were collected at the firm level, the study's results may not be directly comparable to previous studies which have examined cost economies for fleets of life insurers (e.g., Fields, 1988). As a result, caution should be taken in comparing this paper's results to those studies which use fleet data. There are several advantages to examining cost economies at the firm level. First, aggregating firms into fleets can distort the observed level of cost economies. For example, a fleet may be comprised of a group of firms operating with increasing scale economies and another group at decreasing scale economies with neither group operating at the optimal scale of outputs. Aggregating these firms into a fleet, however, may erroneously show that the fleet operates at constant scale economies. Another advantage of examining cost economies at the firm level is that many firms within a fleet can essentially be operated on a stand-alone basis. Hence, combining firms into fleets may produce less insightful and perhaps erroneous results. A major disadvantage, however, of examining cost economies at the firm level is that individual firm's cost characteristics may be distorted due to an "unequitable" cost allocation within the fleet.

Table 1

1987 Insurance Product Line Output, Percentages of Total Output, and Total Asset Averages by Ownership/Marketing Characteristics
(Amounts are in millions of dollars)

		Insurance Line						
Ownership/Marketing Characteristics	N	Ordinary		Group			A&H	Total Assets
		Investments	Life	Annuity	Annuity	Life		
Total Sample	423	\$1,815	\$171 (43.1%)	\$44 (11.1%)	\$37 (9.3%)	\$41 (10.3%)	\$104 (26.1%)	\$1,952
Non-agency Stocks	72	720	133 (50.1%)	65 (24.8%)	15 (5.7%)	11 (4.2%)	38 (14.5%)	820
Non-agency Mutuals	13	1,653	131 (54.8%)	15 (6.3%)	3 (1.2%)	13 (5.4%)	77 (32.2%)	1,778
Agency Stocks	279	1,124	127 (43.5%)	40 (13.7%)	27 (9.2%)	21 (7.2%)	96 (32.9%)	1,222
Agency Mutuals	59	6,452	436 (43.4%)	40 (4.0%)	150 (14.9%)	150 (14.9%)	228 (22.7%)	6,829

The largest proportion of the sample firms are agency stocks which average approximately \$1.2 billion in total assets. Non-agency stock and mutual companies comprise approximately one-fifth of the sample and are generally smaller than the average sized firm in most output categories. Agency mutuals make-up approximately 15 percent of the sample and are largest in terms of assets and all output categories except ordinary annuities.

Estimation and Empirical Results

Estimation

Full information maximum likelihood (FIML) is used to jointly estimate the model in Equation (6) with factor input share equations. Using Shephard's lemma (Shephard 1970), the share equations are given by $\partial \ln C / \partial \ln p_m = S_m$, for $m = L$ and K , where S_m is the m th input's share of total cost. Since the coefficients in the share equations are a subset of those in the cost function in Equation (6), joint estimation should result in more efficient estimates. However, since $\sum_m S_m = 1$, the capital share is dropped from the joint estimation to avoid singularity.¹⁰ Finally, in the estimation of Equation (6) all variables were scaled by their sample means to allow for unbiased hypothesis testing (see Spitzer, 1985).

Empirical Results

Table 2 reports the FIML estimates and asymptotic standard errors of the parameters of the hybrid translog approximation in Equation (6).

Own-Price and Elasticities of Substitution: Insights into the reasonableness of the fit of the hybrid translog cost model are provided by examination of the Allen-Uzawa own-price elasticities and partial elasticities of substitution. The Allen-Uzawa own price and partial elasticities of substitution can be derived using the parameter estimates reported in Table 2 and the average factor shares, S_m 's (see Binswanger, 1974). Theory requires that the own-price elasticities be negative and that the substitution matrix $[\sigma]$ be negative semidefinite.

The own price elasticities are calculated as

$$\sigma_{m,m} = (\alpha_{m,m}/S_m) + S_m - 1, \quad (7)$$

and the partial elasticities of substitution are calculated

$$\sigma_{m,n} = (\alpha_{m,n}/S_m S_n) + 1, \text{ for } m \neq n. \quad (8)$$

Inputs are substitutes if $\sigma_{m,n} > 0$, and complements if $\sigma_{m,n} < 0$.

The estimated elasticities, using average shares for the overall sample, are: $\sigma_{L,L} = -0.266$ and $\sigma_{K,K} = -0.866$ which are both significantly less than zero at the .01 level. The partial elasticity of substitution for labor and capital, $\sigma_{L,K}$, equals 0.916 which is also significant at the .01 level and suggests that labor and capital are substitutes. In addition, the substitution matrix, $[\sigma]$, is negative definite when evaluated using the overall sample mean values of the factor shares. These results therefore suggest that the estimates from Equation (6) represent those for a reasonable, concave, cost function.

¹⁰ Barten (1969) shows that maximum likelihood estimates are invariant to which one of the share equations is dropped from the joint estimation.

Table 2
Translog Cost Function Parameter Estimates
(Asymptotic Standard Errors in Parenthesis)

INTERCEPT	1.064* (0.145)	LABOR*GRPLIFE	-.004 (0.003)
LABOR	0.697* (0.021)	CAPITAL*GRPLIFE	0.004 (0.003)
CAPITAL	0.303* (0.021)	LABOR*GRPANN	-0.001 (0.002)
LABOR*CAPITAL	-0.005 (0.005)	CAPITAL*GRPANN	0.001 (0.002)
LABOR ²	0.005 (0.005)	LABOR*A&H	-0.001 (0.002)
CAPITAL ²	0.005 (0.005)	CAPITAL*A&H	0.001 (0.002)
INV	0.412* (0.086)	INV*ORDLIFE	0.032* (0.032)
ORDLIFE	0.090 (0.071)	INV*ORDANN	0.005 (0.011)
ORDANN	-0.002 (0.029)	INV*GRPLIFE	0.036* (0.017)
GRPLIFE	-0.045 (0.042)	INV*GRPANN	0.016† (0.010)
GRPANN	0.056 (0.039)	INV*A&H	-0.035* (0.015)
A&H	0.206* (0.033)	ORDLIFE*ORDANN	0.010 (0.011)
LABOR*INV	-0.019* (0.008)	ORDLIFE*GRPLIFE	-0.025* (0.011)
CAPITAL*INV	0.019* (0.008)	ORDLIFE*GRPANN	-0.034* (0.017)
LABOR*ORDLIFE	0.013* (0.006)	ORDLIFE*A&H	0.003 (0.008)
CAPITAL*ORDLIFE	-0.013* (0.006)	ORDANN*GRPANN	-0.005 (0.004)
LABOR*ORDANN	0.002 (0.002)	ORDANN*A&H	0.005 (0.004)
CAPITAL*ORDANN	-0.002 (0.002)	GRPANN*A&H	-0.004 (0.004)

Table 2
(continued)

INV ²	-0.073 (0.053)	MUTUAL*ORDANN	-0.072* (0.035)
ORDLIFE ²	0.012 (0.023)	MUTUAL*GRPLIFE	-0.051 [†] (0.029)
ORDANN ²	0.005 (0.006)	MUTUAL*GRPANN	-0.008 (0.024)
GRPLIFE ²	0.003 (0.007)	MUTUAL*A&H	-0.016 (0.037)
GRPANN ²	0.009 (0.007)	MARKETING*LABOR	0.040 [#] (0.014)
A&H ²	0.040 [#] (0.012)	MARKETING*CAPITAL	-0.040* (0.014)
MUTUAL_INTERCEPT	-0.442 [#] (0.142)	MARKETING*ORDLIFE	0.182* (0.077)
MUTUAL*LABOR	-0.039* (0.017)	MARKETING*ORDANN	0.018 (0.027)
MUTUAL*CAPITAL	0.039* (0.017)	MARKETING*GRPANN	-0.045 [†] (0.024)
MUTUAL*INV	0.226* (0.108)	MARKETING*A&H	-0.002 (0.021)
MUTUAL*ORDLIFE	-0.113 (0.093)	GRPANN*GRPLIFE	-0.002 (0.004)
MARKETING_INTERCEPT	0.088 (0.138)	A&H*GRPLIFE	-0.001 (0.003)
MARKETING*GRPLIFE	0.058 (0.033)	ORDANN*GRPLIFE	-0.003 (0.004)
λ	0.092* (0.025)	MARKETING*INVESTMENT	-0.092 (0.086)

[#] significant at 0.01 level.

* significant at 0.05 level.

[†] significant at 0.10 level.

Significance of Ownership Structure and Marketing Form

Stock vs. Mutual Companies: Fama and Jensen (1985) and Mayers and Smith (1987) argue that due to impediments to monitoring managers' activities mutual life insurers may be less efficient than stock insurance firms. Fields (1988) tested for expense preference behavior in mutual life insurers. He found no significant differences in the cost structures of mutual and stock life insurers. This suggests the absence of expense preference

behavior in mutuals or, at least their expense preference behavior is no worse than in stock companies.

The current study offers additional insights into the possible difference between mutual and stock life insurers. The estimated parameters in the Equation (6) associated with mutual versus stock organizational form can be used to test for differences in the cost structures of the two classes of insurers. The organizational form parameters are: θ_M = the mutual intercept shift parameter, $\theta_{M,m}$'s = the interactive price/mutual parameters, and $\theta_{M,i}$'s = the interactive quantity/mutual parameters. Differences in mutual and stock companies' cost structures are examined by testing the joint hypotheses

$$\theta_M = 0, \quad (9.a)$$

$$\theta_{M,m} = 0 \quad \forall m, \text{ and} \quad (9.b)$$

$$\theta_{M,i} = 0 \quad \forall i. \quad (9.c)$$

The results of a likelihood ratio test (calculated $\chi^2 = 21.53$ with 8 d.f.) indicate that the joint hypotheses can be rejected at the .01 level of significance, suggesting that mutual and stock life insurers' cost structures are significantly different. In addition, the partial $\partial \ln C / \partial D_M = -0.44$ which is significant at the 0.01 level. This, in turn, suggests that managers of mutuals do not exhibit expense preference behavior. These results differ from those reported by Fields (1988). The differences in the studies' results could be due to differences in the two studies' methodologies and samples.

Agency vs. Non-agency Marketing Firms: Since production/distribution structures may also affect costs, a test is conducted to determine whether costs differ significantly for those firms (non-agencies) that primarily produce insurance products, in contrast to those firms (agencies) that produce and distribute insurance products. Tests for differences in the cost structure of agency and non-agency companies are conducted by examining the agency parameters in Equation (6). The agency parameters are: θ_A = the agency intercept shift parameter, $\theta_{A,m}$'s = the interactive price/agency parameters, and $\theta_{A,i}$'s = the interactive quantity/agency parameters. Differences in agency and non-agency companies' cost structures are examined by testing the joint hypotheses

$$\theta_A = 0, \quad (10.a)$$

$$\theta_{A,m} = 0 \quad \forall m, \text{ and} \quad (10.b)$$

$$\theta_{A,i} = 0 \quad \forall i. \quad (10.c)$$

The calculated χ^2 from the likelihood ratio test of the joint hypothesis in Equation (10) equals 26.15, which is significant at the .01 level. This result suggests that agency and non-agency companies exhibit different cost structures. The partial $\partial \ln C / \partial D_A = 0.09$ indicates that agencies exhibit higher costs for a given scale and mix of output than non-agencies. However, $\partial \ln C / \partial D_A$ is not significant at standard levels. In addition, as shown below in Table 3, the results suggest that agency firms generally

exhibit lower overall economies of scale. This is consistent with the existence of greater scale economies in the production of products than in the production and distribution of the same products.

Economies of Scale: Using the parameters reported in Table 2, scale economies were estimated for four groups of companies. The four groups are: 1) non-agency mutuals, 2) non-agency stock companies, 3) agency mutuals, and 4) agency stock companies. For each group, scale economies estimates were derived for the overall sample mean vector of outputs, with each output within the vector scaled by its own overall sample mean. To provide insights into the groups' cost characteristics over a reasonable range of the industry cost manifold, estimates of scale economies were also derived for quartile sample mean output vectors. Within each quartile vector, outputs were again scaled by their overall sample means. The quartile sample mean output vectors were formed by ranking the 423 sample companies by the scaler output metric ($q_{OL} + q_{GL} + q_{OA} + q_{GA} + q_{A\&H}$). Finally, to facilitate the intergroup comparison of scale economies, the overall sample and quartile scale economies estimates for each of the four groups were derived holding the scale and mix of output constant across groups. By utilizing this approach, intergroup variations in scale economies are directly attributable to differences in legal ownership and/or production/distribution structures.

Ray Scale Economies Ray scale economies in Equation (2) at an output vector Q^B , e.g., the overall sample mean or a quartile mean, are defined using the hybrid translog in Equation (6) as

$$RSCE^B = \sum_i \partial \ln C(Q^B) / \partial Q_i = \sum_i \varepsilon_i, \quad (2')$$

where

$$\varepsilon_i = (q_i)^\lambda [\beta_i + \sum_j \beta_{ij} Q_j + \sum_m \Phi_{i,m} \ln P_m + \sum_i \theta_{M,i} D_M + \sum_i \theta_{A,i} D_A]. \quad (11)$$

In Equation (11), $D_M = D_A = 0$ for non-agency stocks, $D_M = 1$ and $D_A = 0$ for non-agency mutuals, 3) $D_M = 0$ and $D_A = 1$ for agency stocks, and $D_M = D_A = 1$ for agency mutuals. Table 3 reports estimates of ray scale economies for the overall sample and quartile mean output vectors for the four groups.

The results in Table 3 show that for the overall sample mean output vector all groups exhibit statistically significant ray scale economies. The results also show that the ray scale economy measures vary substantially in moving from the fourth output quartile to the first quartile. For example, agency stock and mutual companies in the fourth quartile exhibit relatively large and statistically significant ray scale economies, i.e., $RSCE = 0.704$ for agency mutual companies and $RSCE = 0.731$ for agency stock companies. By contrast for agency mutual and agency stock companies in the first quartile, the hypothesis of constant returns to scale cannot be rejected. These results demonstrate the richer insights provided by

Table 3

Overall Scale Economy Estimates by Quartile by Marketing Structure and Legal Form.
(Asymptotic standard errors in parenthesis)

Marketing Structure and Legal Form	Overall	1st Quart	2d Quart	3d Quart	4th Quart
Non-Agency Mutual Companies	0.726 [#] (0.081)	0.783 [#] (0.085)	0.695 [#] (0.071)	0.635 [#] (0.073)	0.608 [#] (0.077)
Non-Agency Stock Companies	0.718 [#] (0.079)	0.820 [*] (0.103)	0.730 [#] (0.069)	0.667 [#] (0.063)	0.636 [#] (0.066)
Agency Mutual Companies	0.803 [#] (0.054)	0.959 [#] (0.091)	0.808 [#] (0.051)	0.748 [#] (0.068)	0.704 [#] (0.079)
Agency Stock Companies	0.837 [#] (0.045)	0.952 (0.061)	0.842 [#] (0.034)	0.773 [#] (0.039)	0.731 [#] (0.047)

[#] significant at the 0.01 level.

^{*} significant at the 0.05 level.

Note: The null hypothesis is the calculated scale economy measure is not significantly different from constant returns to scale, i.e. scale economy = 1.0.

evaluating scale economies for various points along the cost manifold, as well as, for the overall sample mean vector of outputs.

With regard to intergroup comparisons, the results show that stock companies generally exhibit lower ray scale economies (i.e., have a higher measure of RSCE) than mutual companies. The magnitude of the differences in the estimates of the mutual and stock companies' ray scale economies measures does not, however, appear to be either statistically or economically significant. Finally, the results in Table 3 suggest that agencies exhibit substantially lower scale economies than non-agencies for all the sample output vectors examined. These results indicate that for a given scale and mix of outputs and an equal proportional increase in all outputs, agencies incur higher incremental costs than do non-agencies.

It is interesting to compare the results for ray scale economies in Table 3 to those reported by Fields (1988), Fields and Murphy (1989) and Kellner and Mathewson (1983). Using data for 1984, Fields (1988) reports significant diseconomies of scale for a sample of 204 stock and 100 mutual companies. More recently, Fields and Murphy (1989) report significant economies of scale for life insurance agencies. Kellner and Mathewson (1983) examine data for the years 1961, 1966, 1971 and 1976 for Canadian-owned life insurance companies selling in Canada. They report that the hypothesis of constant returns to scale can be rejected in favor of decreasing returns to scale for the years 1966 and 1971. However, for the years 1961 and 1976, their results suggest that average firms exhibited constant returns to scale.

The results of the previous studies and the current study may differ for a number of reasons. First, the output metric employed in each study differs. For example, the current study uses premiums and considerations whereas both Fields (1988) and Kellner and Mathewson (1983) use number of

Table 4

Product Specific Scale Economies by Ownership and Marketing Structures

Panel A					
<i>Nonagency Cos.</i>	<i>Mutual Companies</i>				
Outputs	Overall	1st Quart	2d Quart	3d Quart	4th Quart
INVESTMENTS	-0.232 [#] (0.048)	-0.198 (0.112)	-0.230 [#] (0.059)	-0.234 [#] (0.044)	-0.237 [#] (0.037)
ORDINARY LIFE	0.038 (0.092)	0.097 (0.141)	0.041 (0.098)	0.029 (0.088)	0.042 (0.087)
ORDINARY ANNUITY	0.692 [*] (0.047)	0.073 (0.054)	0.091 (0.049)	0.094 [#] (0.044)	0.098 [*] (0.042)
GROUP ANNUITY	-0.033 (0.022)	-0.024 (0.038)	-0.034 (0.025)	-0.034 [†] (0.020)	-0.041 [†] (0.023)
GROUP LIFE	0.074 [*] (0.022)	0.097 (0.056)	0.078 [*] (0.038)	0.072 [*] (0.033)	0.065 [*] (0.031)
ACCIDENT & HEALTH	-0.096 [#] (0.024)	-0.103 [#] (0.033)	-0.102 [#] (0.025)	-0.093 [#] (0.024)	-0.095 [#] (0.024)

Panel B					
<i>Nonagency Cos.</i>	<i>Stock Companies</i>				
Outputs	Overall	1st Quart	2d Quart	3d Quart	4th Quart
INVESTMENT	-0.260 [#] (0.038)	-0.292 [#] (0.069)	-0.268 [#] (0.040)	-0.257 [#] (0.033)	-0.250 [#] (0.031)
ORDINARY LIFE	-0.051 (0.056)	-0.022 (0.088)	-0.049 (0.062)	-0.054 (0.054)	-0.038 (0.058)
ORDINARY ANNUITY	0.023 (0.024)	-0.004 (0.028)	0.019 (0.026)	0.028 (0.024)	0.035 (0.025)
GROUP ANNUITY	-0.040 [*] (0.031)	-0.031 (0.030)	-0.039 [*] (0.017)	-0.039 [#] (0.014)	-0.047 [#] (0.016)
GROUP LIFE	0.030 (0.028)	0.038 (0.048)	0.031 (0.030)	0.030 (0.025)	0.024 (0.024)
ACCIDENT & HEALTH	-0.108 [#] (0.014)	-0.110 [#] (0.024)	-0.110 [#] (0.015)	-0.101 [#] (0.014)	-0.102 [#] (0.014)

[#] significant at the 0.01 level.^{*} significant at the 0.05 level.[†] significant at the 0.10 level.

Table 4 (continued)

Panel C Agency Cos.		Mutual Companies			
Outputs	Overall	1st Quart	2d Quart	3d Quart	4th Quart
INVESTMENT	-0.254 [#] (0.041)	-0.252 [#] (0.077)	-0.256 [#] (0.041)	-0.252 [#] (0.032)	-0.250 [#] (0.028)
ORDINARY LIFE	-0.083 (0.053)	-0.079 [*] (0.066)	-0.094 [†] (0.052)	-0.095 [†] (0.051)	-0.079 [*] (0.054)
ORDINARY ANNUITY	0.060 (0.039)	0.053 (0.040)	0.072 [*] (0.034)	0.077 [*] (0.031)	0.082 [#] (0.031)
GROUP ANNUITY	-0.002 (0.037)	0.021 (0.037)	0.001 (0.022)	-0.005 (0.018)	-0.012 (0.021)
GROUP LIFE	0.023 (0.037)	0.029 (0.036)	0.025 (0.024)	0.024 (0.022)	0.019 (0.023)
ACCIDENT & HEALTH	-0.099 [#] (0.027)	-0.102 [#] (0.032)	-0.101 [#] (0.024)	-0.092 [#] (0.022)	-0.093 [#] (0.022)

Panel D Agency Cos.		Stock Companies			
Outputs	Overall	1st Quart	2d Quart	3d Quart	4th Quart
INVESTMENT	-0.254 [#] (0.042)	-0.295 [#] (0.062)	-0.259 [#] (0.043)	-0.245 [#] (0.038)	-0.232 [#] (0.037)
ORDINARY LIFE	-0.146 [#] (0.023)	-0.148 [#] (0.034)	-0.149 [#] (0.028)	-0.147 [#] (0.027)	-0.133 [#] (0.032)
ORDINARY ANNUITY	-0.015 (0.021)	-0.021 (0.022)	0.003 (0.016)	0.013 (0.016)	0.021 (0.017)
GROUP ANNUITY	-0.010 (0.018)	0.012 (0.030)	-0.006 (0.014)	-0.010 (0.011)	-0.018 (0.014)
GROUP LIFE	-0.016 (0.020)	-0.022 (0.034)	-0.017 (0.019)	-0.014 (0.016)	-0.017 (0.017)
ACCIDENT & HEALTH	-0.108 [#] (0.014)	-0.109 [#] (0.024)	-0.109 [#] (0.015)	-0.100 [#] (0.013)	-0.101 [#] (0.013)

[#] significant at the 0.01 level.^{*} significant at the 0.05 level.[†] significant at the 0.10 level.

policies as a measure of output. Second, the studies differ in terms of the specification of outputs, e.g., no previous study utilized investments as an output, and the aggregation of outputs, e.g., aggregating all life insurance products versus treating ordinary and group policies separately. These differences should provide direction for future research which tests the sensitivity of the estimates of cost economies to alternative output specification when using a common data base.

Product Specific Scale Economies Product specific scale economies in Equation (3) provides insights into the source(s) of the increasing returns to scale for the ray scale economies measures reported in Table 3. Using the hybrid translog in Equation (6), product specific scale economies are defined as

$$\begin{aligned} \text{PSSCE}_i^B &= \partial^2 C(Q^B) / \partial q_i^2 \\ &= (C(Q^B) / q_i^2) [\beta_{i,i} q_i^{2\lambda} + \varepsilon_i (\varepsilon_i - 1 + \lambda)], \end{aligned} \quad (12)$$

where ε_i is as defined in Equation (11).

Table 4 reports estimates of product specific scale economies for the six outputs q_{INV} , q_{OL} , q_{GL} , q_{OA} , q_{GA} , and $q_{A\&H}$. The product specific scale economies measures are estimated for the overall sample mean and quartile output vectors for the four mutual/stock and agency/non-agency groups. The product-specific scale economies measures reported in Table 4 for quartile output vectors are presented graphically in Figures 2 through 7. As explained earlier, $\text{PSSCE}_i^B < 0$ ($\text{PSSCE}_i^B > 0$) indicates decreasing (increasing) marginal costs.

The results in Table 4 show that the outputs investments (q_{INV}) and accident and health ($q_{A\&H}$) display statistically significant increasing product-specific scale economies for all groups and sample output vectors. The results also suggest that ordinary life insurance (q_{OL}) exhibits increasing returns to scale for agency companies, whereas group annuities, q_{GA} , display increasing returns to scale for non-agency stock companies and perhaps non-agency mutuals. The results in Table 4 indicate, therefore, that the increasing ray scale economies in Table 3, are attributable in part to increasing scale economies for investments, accident and health, and for some companies ordinary life and group annuities. For non-agency mutuals, the results indicate ordinary annuities, q_{OA} , and group life, q_{GL} , exhibit decreasing returns to scale. Table 4 shows that for the output classes ordinary annuities (q_{OA}), group annuities (q_{GA}) and group life (q_{GL}) the estimates of product specific scale economies are generally not statistically different from zero for agency companies. This suggests that for these outputs the hypothesis of constant marginal costs cannot be rejected. The results also indicate constant marginal costs for ordinary annuities and group life policies for stock companies.

Figure 2
Investments

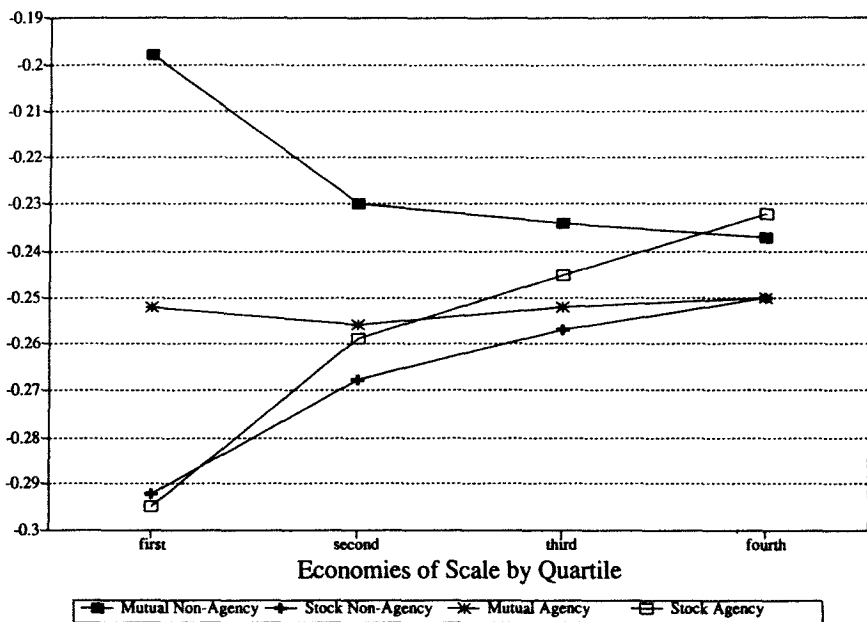


Figure 3
Ordinary Life

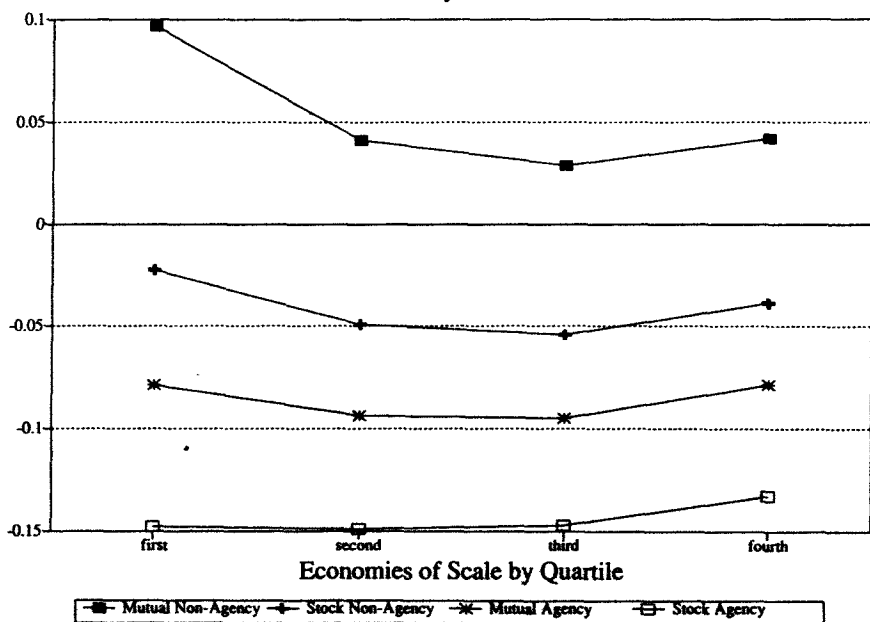


Figure 4
Ordinary Annuity

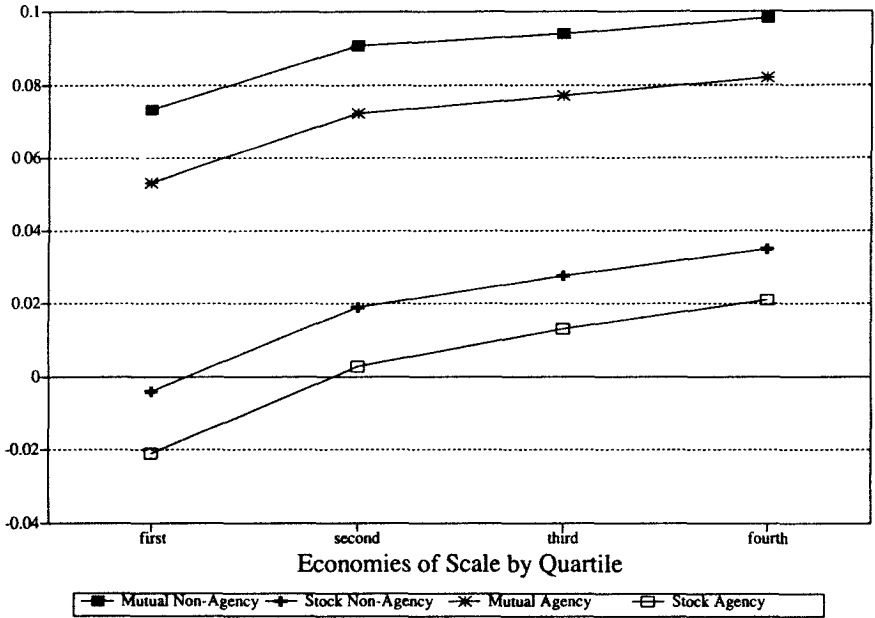


Figure 5
Group Annuity

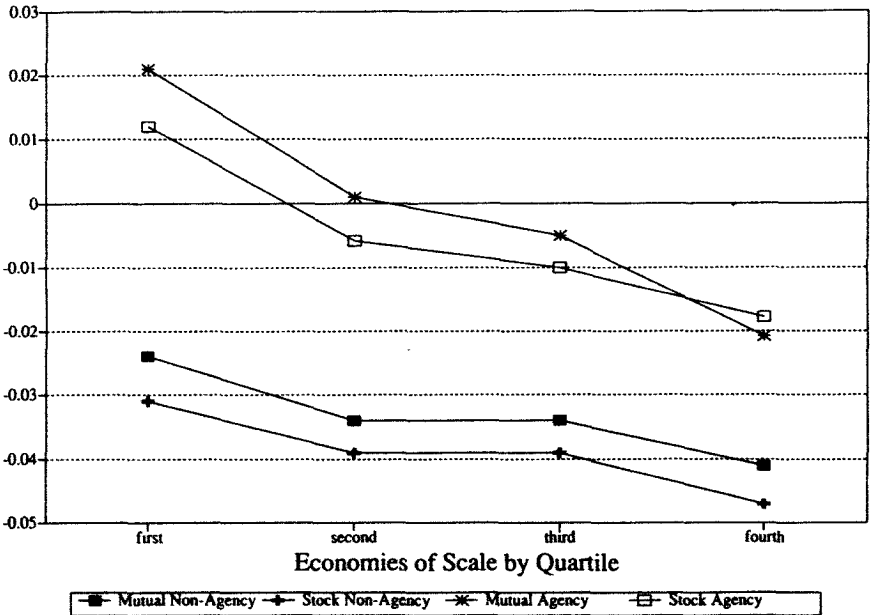


Figure 6
Group Life

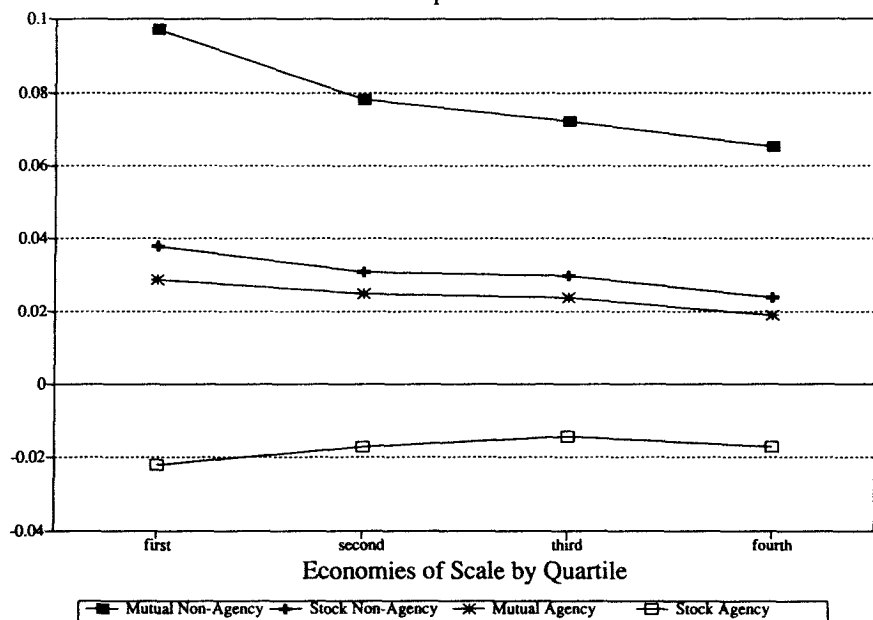
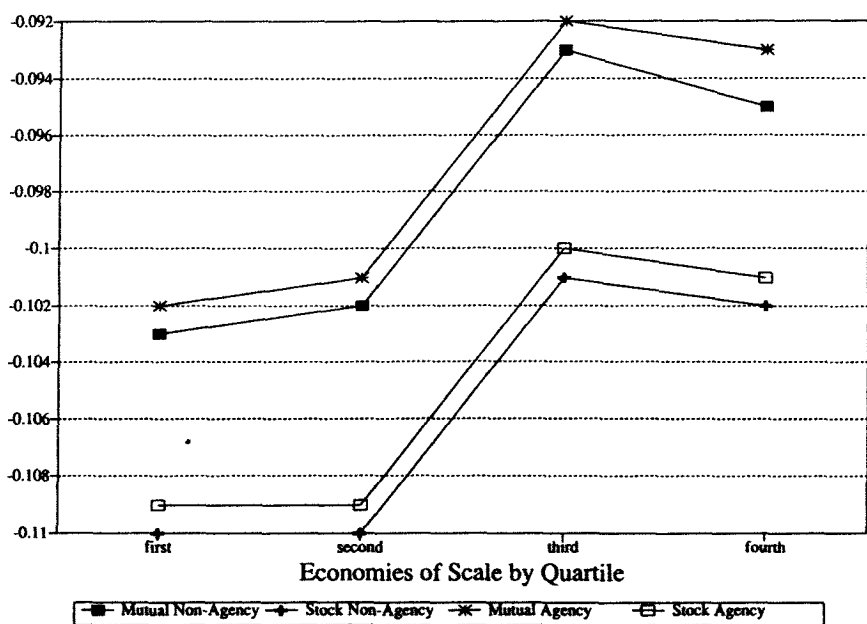


Figure 7
Accident and Health



Examination of the estimates of PSSCE for q_{INV} and $q_{A\&H}$ for the quartile output vectors reveals some variation in the magnitude of the estimates. In Figures 2 and 7, which are plots of the product specific scale economies for investments and accident and health respectively, a consistent pattern across quartiles is detected and the inter-quartile variation does not appear statistically significant. Scale economies for these outputs, therefore, appear not to be fully exhausted for even the largest firms. This result is in contrast to the quartile pattern displayed in Table 3 for ray scale economies that indicates reduced scale economies when moving from the fourth to first quartile.

In summary, the empirical evidence for RSCE suggests that overall economies of scale are generally exhausted for the largest agency firms. Smaller firms and even the largest non-agency companies, however, tend to have significant overall increasing returns to scale. For the product-specific economies of scale, the evidence indicates decreasing marginal costs for investments and accident and health for all firms.

Cost Complementarities Analysis of pair-wise costs complementarities provides insights into economies of scope in the joint production of outputs. Using the hybrid translog, the measure of pair-wise cost complementarities in Equation (4) is stated as

$$CC_{ij}^B = (C(Q^B)/q_i q_j) [\beta_{ij} q_i^\lambda q_j^\lambda + \varepsilon_i \varepsilon_j] \quad (13)$$

where ε_i and ε_j are, respectively, the cost elasticities for outputs q_i and q_j as defined in Equation (11). Table 5, Panels A through D report estimates of pair-wise cost complementarity, CC_{ij} , shown in Equation (13) for the four stock/mutual and agency/non-agency groups for the overall and quartile output vectors.

Table 5 shows that only for the output pairs 1) ordinary and group life, and 2) ordinary life and group annuities do the results suggest cost-savings complementarities, $CC_{ij} < 0$ for all groups and most output vectors. Conversely, the output combination of investments and accident and health consistently exhibits cost-increasing complementarities, $CC_{ij} > 0$ for all groups and most output vectors. The combination of ordinary life and accident and health also exhibits significant cost-increasing cost complementarities for agency mutual and agency stock companies. Interestingly, for the output pairs exhibiting decreasing (increasing) cost savings, these savings become larger (smaller) when moving from the fourth to first output quartile. For all other output combinations, the complementarities are generally not significant, implying a lack of economies of scope. The results in Table 5 are consistent with those reported by Fields (1988) and Kellner and Mathewson (1983) which also report the lack of significant cost complementarities between life insurance companies' outputs.

Viewed narrowly, the results in Table 5 imply that cost complementarities are not the *raison d'etre* for multiproduct production for life insurance companies. It can be argued that the results are consistent with companies

Table 5
Cost Complementarities by Marketing Structure and Organizational Form.

Panel A Non Agency Cos.	Mutual Companies				
Outputs	Overall	1st Quart	2d Quart	3d Quart	4th Quart
INV,OL	0.018 (0.078)	-0.024 (0.120)	0.006 (0.071)	0.010 (0.058)	-0.001 (0.052)
INV,OA	-0.043 (0.034)	-0.047 (0.045)	-0.052 (0.034)	-0.051 (0.029)	0.052 (0.027)
INV,GA	0.046 (0.031)	0.051 (0.043)	0.044 (0.023)	0.038* (0.018)	0.042* (0.019)
INV,GL	-0.025 (0.033)	-0.026 (0.045)	-0.020 (0.027)	-0.018 (0.022)	-0.014 0.020
INV,A&H	0.086* (0.039)	0.126* (0.054)	0.095* (0.034)	0.075* (0.027)	0.072* (0.026)
OL,OA	0.012 (0.012)	0.018 (0.015)	0.012 (0.011)	0.010 (0.010)	0.010 (0.009)
OL,GA	-0.026* (0.011)	-0.035* (0.015)	-0.022* (0.009)	-0.017* (0.008)	-0.018* (0.008)
OL,GL	-0.031 [†] (0.018)	-0.034 [#] (0.021)	-0.026 [†] (0.015)	-0.022 [†] (0.013)	-0.019 [†] (0.011)
OL,A&H	-0.001 (0.002)	-0.015 (0.032)	-0.004 (0.022)	-0.001 (0.017)	-0.004 (0.017)
OA,GA	-0.008 (0.006)	-0.008 (0.007)	-0.008 (0.005)	-0.007 (0.048)	-0.008 (0.005)
OA,A&H	-0.009 (0.009)	-0.009 (0.012)	-0.012 (0.010)	-0.011 (0.007)	-0.012 (0.007)
OA,GL	0.004 (0.007)	0.002 (0.007)	0.004 (0.005)	0.004 (0.005)	0.004 (0.005)
GA,GL	-0.006 (0.006)	-0.006 (0.006)	-0.005 (0.004)	-0.004 (0.003)	0.005 (0.003)
GA,A&H	0.005 (0.008)	0.003 (0.011)	0.005 (0.006)	0.004 (0.005)	0.006 (0.005)
GL,A&H	-0.019 (0.012)	-0.022 (0.018)	-0.015 (0.009)	-0.012 (0.017)	-0.011 (0.006)

Table 5 (continued)

Panel B <i>NonAgency</i> <i>Cos.</i>	Stock Companies				
Outputs	Overall	1st Quart	2d Quart	3d Quart	4th Quart
INV,OL	0.069 (0.046)	0.061 (0.072)	0.059 (0.072)	0.054 (0.042)	0.041 (0.030)
INV,OA	0.004 (0.016)	0.011 (0.016)	-0.002 (0.016)	-0.007 (0.013)	-0.010 (0.013)
INV,GA	0.039* (0.018)	0.046 (0.027)	0.037* (0.014)	0.032# (0.011)	0.035# (0.012)
INV,GL	0.017 (0.022)	0.026 (0.034)	0.017 (0.019)	0.013 (0.014)	0.013 (0.013)
INV,A&H	0.050 [†] (0.029)	0.079 [†] (0.043)	0.061* (0.024)	0.049# (0.018)	0.047# (0.017)
OL,OA	0.010 (0.010)	0.013 (0.013)	0.008 (0.009)	0.006 (0.009)	0.005 (0.006)
OL,GA	-0.020* (0.010)	-0.029* (0.014)	-0.016 [†] (0.009)	-0.012 (0.008)	-0.012 (0.008)
OL,GL	-0.038* (0.019)	-0.044 (0.029)	-0.031* (0.014)	-0.026* (0.012)	-0.023* (0.010)
OL,A&H	0.021 (0.021)	0.014 (0.029)	0.017 (0.018)	0.015 (0.015)	0.011 (0.014)
OA,GA	-0.005 (0.005)	-0.005 (0.006)	-0.005 (0.004)	-0.005 (0.003)	-0.005 (0.004)
OA,A&H	-0.005 (0.007)	-0.008 (0.009)	0.002 (0.007)	0.001 (0.005)	-0.002 (0.005)
OA,GL	-0.003 (0.004)	-0.004 (0.006)	-0.002 (0.004)	-0.002 (0.003)	-0.001 (0.003)
GA,GL	-0.004 (0.004)	-0.004 (0.005)	-0.003 (0.003)	-0.003 (0.003)	-0.003 (0.003)
GA,A&H	0.007 (0.007)	0.006 (0.010)	0.008 (0.006)	0.006 (0.004)	0.008 (0.005)
GL,A&H	-0.010 (0.010)	-0.010 (0.018)	-0.007 (0.008)	-0.005 (0.005)	-0.004 (0.005)

Table 5 (continued)

Panel C Agency Cos.	Mutual Companies				
Outputs	Overall	1st Quart	2d Quart	3d Quart	4th Quart
INV,OL	0.119* (0.045)	0.119* (0.059)	0.104* (0.039)	0.095* (0.033)	0.076* (0.030)
INV,OA	-0.026 (0.024)	-0.027 (0.032)	-0.035 (0.023)	-0.036 (0.020)	-0.037* (0.019)
INV,GA	0.018 (0.022)	0.013 (0.032)	0.017 (0.016)	0.016 (0.012)	0.020 (0.013)
INV,GL	0.016 (0.024)	0.027 (0.034)	0.017 (0.019)	0.013 (0.016)	0.014 (0.015)
INV,A&H	0.068* (0.032)	0.102* (0.044)	0.078* (0.026)	0.061* (0.021)	0.059* (0.021)
OL,OA	0.001 (0.013)	0.007 (0.015)	0.001 (0.010)	-0.002 (0.010)	-0.002 (0.009)
OL,GA	-0.025* (0.011)	-0.033* (0.015)	-0.019* (0.009)	-0.015* (0.007)	-0.014* (0.007)
OL,GL	-0.039* (0.017)	-0.046* (0.023)	-0.032* (0.014)	-0.027* (0.011)	-0.023* (0.009)
OL,A&H	0.033+ (0.019)	0.030 (0.024)	0.029+ (0.017)	0.024* (0.014)	0.020 (0.014)
OA,GA	-0.005 (0.004)	-0.005 (0.005)	-0.005 (0.004)	-0.004 (0.003)	-0.005 (0.003)
OA,A&H	-0.006 (0.008)	0.005 (0.010)	-0.008 (0.008)	-0.008 (0.006)	-0.009 (0.006)
OA,GL	-0.001 (0.005)	-0.003 (0.006)	-0.001 (0.004)	-0.001 (0.004)	-0.001 (0.004)
GA,GL	-0.002 (0.003)	-0.002 (0.004)	-0.002 (0.003)	-0.001 (0.002)	-0.001 (0.002)
GA,A&H	-0.004 (0.008)	-0.008 (0.011)	-0.002 (0.006)	-0.001 (0.004)	0.000 (0.005)
GL,A&H	-0.008 (0.008)	-0.008 (0.014)	-0.005 (0.006)	-0.004 (0.004)	-0.003 (0.004)

Table 5 (continued)

Panel D Agency Cos.	Stock Companies				
Outputs	Overall	1st Quart	2d Quart	3d Quart	4th Quart
INV,OL	0.119 [#] (0.035)	0.141 [#] (0.051)	0.113 [#] (0.027)	0.102 [#] (0.021)	0.085 [#] (0.019)
INV,OA	0.010 (0.012)	0.018 [†] (0.017)	0.005 (0.010)	0.001 (0.008)	-0.003 (0.008)
INV,GA	0.020 (0.013)	0.020 (0.020)	0.018 [†] (0.010)	0.016 [*] (0.007)	0.019 [*] (0.008)
INV,GL	0.040 [*] (0.020)	0.057 (0.030)	0.038 [*] (0.016)	0.032 [#] (0.012)	0.030 [#] (0.012)
INV,A&H	0.031 (0.024)	0.054 (0.035)	0.043 [#] (0.018)	0.035 [#] (0.013)	0.034 [#] (0.013)
OL,OA	0.015 (0.025)	0.020 (0.057)	0.016 (0.010)	0.008 (0.009)	0.003 (0.007)
OL,GA	-0.022 [†] (0.013)	-0.032 [†] (0.017)	-0.017 [†] (0.009)	-0.012 [†] (0.007)	-0.010 (0.007)
OL,GL	-0.030 (0.019)	-0.035 (0.026)	-0.023 (0.040)	-0.020 [*] (0.011)	-0.017 [*] (0.008)
OL,A&H	0.058 [#] (0.015)	0.061 [#] (0.020)	0.052 [#] (0.013)	0.043 [#] (0.011)	0.037 [#] (0.011)
OA,GA	-0.005 (0.004)	-0.006 (0.006)	-0.004 (0.004)	-0.003 (0.003)	-0.004 (0.003)
OA,GL	0.008 (0.006)	0.013 (0.009)	0.005 (0.006)	0.002 (0.004)	0.001 (0.004)
OA,A&H	-0.003 (0.004)	-0.003 (0.006)	-0.002 (0.004)	-0.003 (0.003)	-0.003 (0.003)
GA,GL	-0.002 (0.004)	-0.002 (0.005)	-0.001 (0.003)	-0.007 (0.003)	-0.001 (0.003)
GA,A&H	-0.002 (0.007)	-0.006 (0.010)	-0.001 (0.005)	0.001 (0.004)	0.002 (0.005)
GL,A&H	0.002 (0.008)	0.005 (0.015)	0.004 (0.005)	0.003 (0.004)	0.004 (0.004)

[#] significant at the 0.01 level.^{*} significant at the 0.05 level.[†] significant at the 0.10 level.

offering output configurations that minimize both firm production costs and consumer-borne transaction costs or with a product diversification motive. While these arguments are valid, they represent less than a complete justification for multiproduct production in the absence of subadditive costs. Economies of scope combined with increasing returns to scale, which are generally shown to exist in Table 3, are sufficient but not necessary for multiproduct production. It is quite possible for multiproduct production to be optimal when outputs are produced independently (Levy and Haber, 1986, and Teece, 1980 and 1982). It is only required that inputs be sharable as opposed to joint.

As argued by Teece (1980, 1982), market contracting is inferior to production within a multiproduct firm when inputs are transaction-specific and must be exchanged on a recurring basis. Transaction-specific inputs in insurance include both indivisible physical capital which is common to two or more products and human capital. The lumpy nature of most physical capital means that these inputs are likely to be only incompletely utilized in the production of a single product. Efficiency then dictates the sharing of input services among several outputs. The special nature of these inputs make their exchange through market contracts very risky, since these inputs by their very nature have only a few potential users.

Human capital inputs can be used to produce more than one output, but these inputs are also quite costly to transfer between firms. Items such as know-how and organizational knowledge are important but elusive.¹¹ Market contracts for the transfer of these inputs are both difficult to specify and to enforce. As a consequence transfers of these items are more easily accomplished within a multiproduct firm, due to more highly developed information networks, auditing capabilities and internal reward schemes.

One last advantage of the multiproduct form of production is the flexibility it allows in dealing with uncertainty. For example, these firms may reallocate their firm-specific inputs among product lines in response to unanticipated shocks. In addition, the firm has the option of transferring inputs to higher valued uses in a timely manner. This ability allows the firm to avoid the high transactions costs associated with rapidly accumulating firm-specific capital.¹²

The key factors underlying these advantages of the multiproduct form of production are the ability to revise production plans in response to unanticipated shocks and the prohibitive nature of the transactions costs associated with market contracting for firm and product-specific inputs. These factors imply that it is the shareability of inputs as opposed to any 'publicness' of inputs which is necessary for multiproduct production. Public

¹¹ Prescott and Visscher (1980) cite the following examples of firm-specific human capital: knowledge about the abilities and efforts of personnel, information about the matching of employees with tasks, and technological knowledge specific to the production methods or organizational methods of the firm.

¹² See Lucas (1967) for a discussion of this point.

inputs give rise to joint production and hence the notion of economies of scope.¹³ Sharable inputs, on the other hand, are transferable between users, but are used in producing only one output at a time. From an *ex ante* perspective, these inputs may be seen as public in the sense that they may be allocated alternatively between products. However, once allocated, the production of different products may be independent. This distinction is key. The shareability of inputs provides an economic justification for multiproduct production even when the production of multiple products is independent. Traditional cost subadditivity is thus seen to be a sufficient but not necessary condition for the multiproduct form of production. Thus, it should pay researchers in future studies of the production economics of the large multiproduct insurance firm to explicitly account for such factors as inputs shareability and flexibility in their analyses.

Summary and Conclusions

This study employs a multiproduct estimation methodology to provide information about cost economies for the U.S. life insurance industry. Several sets of cost characteristics are estimated for a variety of sample firms differing in the scale and mix of outputs. This contrasts sharply with previous studies which have only provided a single set of estimates derived from the industry sample mean. The results show that most firms had significant economies of scale while the largest agency companies exhibited approximately constant returns to scale. In addition, there is in general a surprising lack of cost complementarities in the multiproduct insurance firm. Only for ordinary and group life and ordinary life and group annuities do the results suggest universally decreasing cost complementarities. These results suggest that multiproduct insurance firms exist not as a means to exploit economies of scope, but perhaps due to a relatively large amount of firm specific human and physical capital which can be used more effectively in a multiproduct firm.

In addition, the study finds that legal organizational form and marketing structure have significantly different cost structures. Differences related to legal form do not suggest that mutual companies incur higher costs and lower scale economies than stock companies holding the scale and mix of outputs constant. Regarding marketing structure, the results show non-agencies exhibit larger returns to scale than agencies, again holding output mix and scale constant.

The existence of scale economies for a large numbers of firms suggest that there may be market imperfections (due to, for example, information asymmetries or state regulation) which prevent firms from capturing the full benefits of increasing returns to scale. Public policy may require incentives

¹³ According to Panzar and Willig (1981), economies of scope exist because the firm possesses public inputs. That is, multiproduct firms have a cost advantage over specialty firms because they can internalize the advantage conveyed by public inputs.

for small to medium size companies to merge to better exploit cost economies and, therefore, compete more effectively against larger firms. Finally, this study suggests that differing estimates of scale economies by various researchers should be vigorously examined, as different samples and different model specifications may result in significantly different estimates.

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