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The Economic Performance of the Canadian Insurance Business

Tarek Harchaoui

(Industrial Organization and Finance Division, Statistics Canada)

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The Economic Performance of the Canadian Insurance Business
Scale, Scope and Productivity Measurement *

By Tarek M. Harchaoui
Industrial Organization and Finance Division
Statistics Canada
Jean Talon Bldg., 10-B6
Ottawa, Ontario
K1A OT6
E-mail: harctar@statcan.ca

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Abstract: Network effects have been shown in theory to have implications for a variety of activities. Although previous attempts have introduced the network effect mainly in banking activities, its application to the insurance business where each firm has access to a wide network of agents and brokers seems to be a natural extension. This paper formulates a short-run production framework that accounts for network externalities. The application of this framework to the modelling of total factor productivity allows for the distinction between i) scale economies, ii) temporary equilibrium, iii) market structures, and iv) technological change. Based on an incomplete panel data set at the firm level for the period 1985-1995, the results suggest that, with a 2.6 percent average annual growth rate of total factor productivity for life insurance companies and .8 percent for non-life insurance companies, the insurance business outperformed both goods-producing industries and non-financial services industries. Scale economies represent the major component of these TFP growth rates, followed by technological change, market structures and the temporary equilibrium effect. In general, although total factor productivity growth tends to decline with the size of firms, large firms still display productivity gains.

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I. Introduction

Much progress has been made toward understanding the production economics of manufacturing and non-financial services industries. Analysts, employing improved statistical methodologies and measurement techniques, have produced an impressive body of results about which there appears to be a growing consensus. Despite the impressive body of results available on production in these industries, it is only recently that studies analysing the structure of production in financial services industries have appeared. This is somewhat surprising, given the importance of financial services industries in the economic activity. Recent developments of intermediaries and the increasing importance of financial services in the economic activity in advanced countries have focused attention on the activities of banks. Although banks may be the financial institutions we deal with most often, they are not the only financial intermediaries households and businesses come in contact with. Non-bank financial intermediaries play as important a role in channeling funds from lenders-savers to borrowers-spenders as banks do. In Canada for example, among these financial intermediaries, insurance companies play a major role, since they account for about 15 percent of the financial assets of all financial institutions, second after chartered banks. In addition, the flows of revenue generated by the insurance business through its role as a conduit for savings of all kinds are considered to be important enough to require substantial government protection and supervision.

Considerable attention has been given to the measurement of various economic performance indicators and the characterization of the underlying technology of the insurance firm. The literature has been characterized by a steady progression from simple investigations of a monoproduct technology (Braeutigam and Pauly 1986) to the specification of multiproduct cost functions (Grace and Timme 1993; Suret 1990) and recently to the taking into account of the financial intermediation activity in the measurement of insurance companies' output (Bernstein 1992). Despite the impressive nature of the results obtained in the literature to date on insurance firms' cost structure, several important limitations still exist. First, virtually all studies have ignored the importance of the network effect, which has been shown to have an important impact on activities such as banking. It is particularly important to account for the network effect for firms in which services are provided over a network of spatially distributed points as cost per unit of output may vary among firms depending on the nature of their network served. Despite the fact that the importance of a network is nowhere as obvious as in the insurance business, it is surprising that there have not been any attempts to measure these effects on firms' performance. Previous attempts have introduced the network effect in the behaviour of the banking industry (see Saloner and Shephard 1995); the application of this effect to insurance firms' activities seems to be a natural extension. Second, except for studies of economies of scale (and recently of scope), little attention has been given to the general area of productivity analysis in the insurance business as whole. [1]

The primary focus of this paper is on modelling and estimating the total factor productivity (TFP) of the growth of the insurance business at the firm level. The measurement and analysis of TFP growth is important, especially given the recent trends that have taken place in this industry. For example, government tax policy has had a profound effect on the demand for life insurance and on the product mix. Policies that have encouraged savings through tax-sheltered registered retirement savings plans (RRSPs) have increased demand for annuities both for individuals who initially register their RRSPs with a life insurance company and for those who purchase an annuity upon maturity of an RRSP originally registered with another financial institution. In addition, the insurance industry was considered a pioneer in the financial services industries because it was the first to use financial systems technologies such as electronic data processing (see Globermann 1986). The investments undertaken by insurance companies also raise questions regarding the effect of these new technologies on

[1] The exception is Daly et al. (1985), who measured productivity in the Canadian life insurance industry.

the efficiency of undertaking insurance activities. There are also reasons to believe that because of the very nature of insurance activity, a significant portion of the inputs are represented by the size of the retail activity network, a quasi-fixed input in the short run. When measuring cost changes and productivity gains, these factors must be taken into account, including the possibility of a temporary equilibrium which may occur when unexpected demand shocks lead to under- or over-utilization of capacity.

Using an incomplete panel data set, this paper attempts to meet the challenges mentioned above in measuring TFP in the Canadian insurance business during the period 1985-1995. This incomplete panel data set results from i) the use in the sample of only multiproduct firms and ii) these multiproduct firms displayed a substantial turnover rate during the period under investigation. Accordingly, to obtain unbiased estimates of the cost structure and the related economic performance indicators, the estimation technique needs to account for selectivity bias as the used sample may not well represent monoproduct firms excluded from the sample and the portion of multiproduct firms that are subject to entry/exit. The econometric approach to the estimation of the cost structure relies on the methodology developed by Baltagi and Griffin (1988) and extended by Dionne and Gagné (1992) to an incomplete panel data set. The TFP growth framework is broken down into its main components: 1) scale economies, 2) market structures, 3) temporary equilibrium, and 4) technological change. It is applied to life and property and casualty (P&C) insurance companies operating in Canada as an illustration.

The results shown in this paper suggest that the existence of a network allows large insurance companies to exhibit returns to scales that are higher than those of small and medium-sized firms. In addition, cost-savings from joint production and TFP growth are greater for small and medium-sized firms, but they have a tendency to decline for larger ones. Overall, for the period spanned by the data, the TFP of life and non-life insurance business grew, respectively, at an enviable average annual rate of growth of 2.6% and .81%, compared with a negative annual average rate of 0.39% for goods-producing industries and 0.48% for non-financial services producing industries. Scale economies represent the major component of these TFP growth rates, followed by technological change, market structures and the temporary equilibrium effect.

The remainder of the paper is organized as follows: Section II outlines the need for an alternative production framework for insurance firms and introduces the appropriate productivity framework. Section III discusses the data set and the measurement of variables. Section IV presents the estimation techniques. The parameter estimates of the restricted cost function and the TFP growth estimates are discussed in section V. Section VI gives a brief summary of the paper.

II. Theoretical Framework

1. Specification of the Technology

The technology of an insurance company shares most of the characteristics of the technology of any other activity in services industries. It uses standard factors of production like capital $K(t)$, labour $L(t)$, and intermediate inputs $M(t)$, where t represents time $t = 1,2,...,T$. Besides the primary and intermediate inputs that are used in many other businesses, an insurance firm requires the use of a network of agents and brokers $N = N(t)$, a quasi-fixed input, to provide retail services to policyholders (sell insurance policies, provision of information, etc.). The quasi-fixed nature of this input follows from the significant adjustment costs and the time required to dismantle or significantly alter the size of this network. Insurance companies incur 'setup costs' when establishing their retail activities.

As a result of these setup costs and the contractual arrangements with brokers and agents, insurance companies are less likely to reduce the size of the network during periods when, at the margin, the network is not needed but is expected to be needed in the future. Factors other than adjustment costs may also explain the quasi-fixed nature of this input. Regulatory restrictions, inflexible organizational structures and other institutional rigidities may all provoke short-run fixities. [2]

The combination of these inputs and the technological knowledge prevailing in the economy $A = A(t)$ allows the insurer to produce a vector of output $Y = Y(t)$ under the following short-run cost function:

$$G(w, Y, N, A), \tag{1}$$

where $w = \left(w_K(t), w_L(t), w_M(t)\right)$ is a vector of the prices of the variable inputs (K, L, M).

A fundamental measure identifying the network's impact on productive performance is the shadow value of the network. This cost effect, expressed as a variant of Shephard lemma (see Diewert 1982), is $-\left(\frac{\partial G}{\partial N}\right) = z$. The shadow value, which shows the cost-savings attributed to the availability of a network because of substitutability with other inputs, can be considered a dual measure of the marginal product of the network N. In this case, the 'returns' to the network are directly expressed in terms of cost-savings given a particular output level rather than in terms of the additional output possible given the available inputs. This measure should be positive if the marginal product is positive, and the size of the measure suggests how important the returns to the network are to firms' costs.

To explore the network's contribution in more depth, these measures must be further adapted to deal with additional issues such as the cost and benefits of the network. The shadow value and market price of the network are useful for evaluating the price when making decisions about networks. These decisions

[2] See Hunter and Timme (1993).

involve considering how the benefits or returns reflected by the shadow value relate to the associated costs, taking into account the stock-flow nature of the network. Constructing the price of the flow of the network can be accomplished similarly to constructing a user cost of capital. Optimal choice of a network requires that $z = u$; z represents the additional marginal benefit obtained by adding one more unit of N, and u measures its marginal cost. Thus, the optimal stock level depends on both the cost-saving benefits and the cost of investment. The cost-benefit comparison can be expressed either by constructing a shadow value ratio, or a measure analogous to 'Tobin's q', $\frac{z}{u}$. If z exceeds (falls short of) u, the firm should invest (disinvest) in the network to reach its cost-minimizing network size. This implies that, in present-value terms, a measure of the long-term returns to a one-dollar investment in the base year's dollars can be obtained by dividing z by u. That is, the one-year return on investment in N is z, but the present value of all returns is $\frac{z}{u}$. If this ratio exceeds 1, one more dollar of investment (in constant base-year prices) should be undertaken. Differences between the transaction's rental prices u and z are usually thought to be due to the presence of increasing marginal costs of adjustment for the quasi-fixed inputs.

2. The Total Factor Productivity Framework

In the past couple of decades, production theory models based on duality theory have been shown to be a rich framework for analysis of firms' technology and behaviour (see Denny et al. 1981). The basic framework can be extended to consider a broad array of factors affecting firms' decisions and performance in financial services industries. The dual approach to traditional TFP measurement under the assumption of temporary equilibrium is derived from the existence of a variable cost function $G = G(w, Y, N, A)$.[3] Define the long-run implicit cost function as

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[3] For the introduction of the temporary equilibrium effect in productivity measurement, see Berndt and Fuss (1986).

$$C = G(w, Y, N, A) + zN. \tag{2}$$

The total differentiation of (2) with respect to time t, dividing throughout by C, using the modified versions of Shephard lemma ($\frac{\partial G}{\partial w_i} = X_i$ and $-\frac{\partial G}{\partial N} = z$), and rearranging terms, yields

$$\frac{\dot{C}}{C} = \frac{\dot{B}}{B} + \sum_s \varepsilon_{G,Y_s} \frac{\dot{Y}_s}{Y_s} + \sum_i \frac{w_i X_i}{C} \frac{\dot{w}_i}{w_i} + \frac{zN}{C} \frac{\dot{z}}{z}. \tag{3}$$

The total differentiation of $C = \sum_i w_i X_i + zN$ with respect to time and rearranging gives

$$\frac{\dot{C}}{C} = \sum_i \frac{w_i X_i}{C} \frac{\dot{w}_i}{w_i} + \sum_i \frac{w_i X_i}{C} \frac{\dot{X}_i}{X_i} + \frac{zN}{C} \frac{\dot{z}}{z} + \frac{zN}{C} \frac{\dot{N}}{N}. \tag{4}$$

Substituting (4) into (3) gives

$$-\frac{\dot{B}}{B} = \sum_s \varepsilon_{G,Y_s} \frac{\dot{Y}_s}{Y_s} - \sum_i \frac{w_i X_i}{C} \frac{\dot{X}_i}{X_i} - \frac{zN}{C} \frac{\dot{N}}{N}, \tag{5}$$

where $\frac{\dot{Y}^G}{Y^G} \equiv \left(\sum_s \varepsilon_{G,Y_s} \right)^{-1} \left(\sum_s \varepsilon_{G,Y_s} \frac{\dot{Y}_s}{Y_s} \right)$.

Note that under the standard assumptions underlying the non-parametric TFP framework—constant return to scales, perfect competition and no quasi-fixed factor of production—TFP growth is defined as $\frac{T\dot{F}P}{TFP} = \frac{\dot{Y}^P}{Y^P} - \sum_i \frac{w_i X_i}{\tilde{C}} \frac{\dot{X}_i}{X_i} - \frac{uN}{\tilde{C}} \frac{\dot{N}}{N}$ where $\frac{\dot{Y}^P}{Y^P} \equiv \sum_s \left(\frac{P_s Y_s}{\sum_s P_s Y_s} \right) \frac{\dot{Y}_s}{Y_s}$, P_s is the market price of the output s, $\tilde{C} = \sum_i w_i X_i + uR$ designates the total cost defined in terms of market prices, and u represents the rental cost of the network N. Adding $\frac{\dot{Y}^G}{Y^G} - \frac{\dot{Y}^G}{Y^G}$, $\frac{\dot{Y}^P}{Y^P} - \frac{\dot{Y}^P}{Y^P}$ and $\frac{uN}{\tilde{C}} \frac{\dot{N}}{N} - \frac{uN}{\tilde{C}} \frac{\dot{N}}{N}$ on the right-hand side of (5) and using the above definition of TFP growth gives the following new measurement framework of TFP growth:

$$\frac{T\dot{F}P}{TFP} = -\frac{\dot{B}}{B} + \left(1 - \sum_s \varepsilon_{G,Y_s} \right) \frac{\dot{Y}^G}{Y^G} + \left(\frac{\dot{Y}^P}{Y^P} - \frac{\dot{Y}^G}{Y^G} \right) + \left(\frac{zN}{C} - \frac{uN}{\tilde{C}} \right) \frac{\dot{N}}{N} \tag{6}$$

Given the information on the growth rate of output s, its cost elasticity, the inputs and their cost shares, one can use (6) to estimate TFP growth and breakdown this measure into the factors contributing to TFP growth rates. These factors include i) a shift in the cost function due to technical change $\left(-\frac{\dot{B}}{B}\right)$, ii) a movement along the cost function due to scale economies $\left(1-\sum_{s}\varepsilon_{G,Y_s}\right)\frac{\dot{Y}^G}{Y^G}$, iii) departures from marginal cost pricing $\left(\frac{\dot{Y}^P}{Y^P}-\frac{\dot{Y}^G}{Y^G}\right)$, and iii) the temporary equilibrium effect $\left(\frac{zN}{C}-\frac{uN}{\tilde{C}}\right)\frac{\dot{N}}{N}$. This last component deserves further explanation.

It has long been recognized that the existence of temporary equilibrium, especially that associated with the business cycle, can bias measured productivity growth away from its long-run path. The productivity residual is adjusted in a consistent manner to accommodate forms of temporary equilibrium, such as variation in the utilization rates of the network. Temporary equilibrium may occur when unexpected demand shocks lead to under- or over-utilization of capacity, or when sudden changes in factor prices result in short-run relative factor usage, which is inappropriate in the long-run. The above TFP framework does not assume that producers are in the long-run equilibrium when in fact they may be in short-run or temporary equilibrium. The proposed framework accounts for temporary equilibrium by altering the service price weights of the quasi-fixed inputs, rather than directly altering their quantities.

III. Data Sources and Measurement Issues

This study uses administrative data collected by the Office of the Superintendent of Financial Institutions (OSFI) on operations that insurance companies (life insurance and P&C insurance) booked in Canada during the period 1985 to 1995. The particular data set employed contains information on premiums earned and claims incurred by product line, investment income, and general expenses. From this data set, I retained only the companies operating under a multiproduct technology: i.e., P&C insurance companies providing automobile insurance, property insurance, and liability insurance and life insurance companies providing life insurance and annuities. By excluding monoproduct companies, I could avoid using econometric techniques, such as the Box-Cox estimation method, which give results that are not invariant to units of measure (see Dagenais and Dufour 1992).

The data on multiproduct firms was linked to the data collected by Statistics Canada's Survey of Employment, Payroll and Hours and to the data on capital stocks and investments from the Division of Investment and Capital Stock in order to obtain the data on capital and labour. Variable costs, G, include labour compensation, capital services, and miscellaneous expenses. Labour expenses are comprised of salaries, wages, and benefits. Capital expenses equal the sum of the rental cost of buildings and equipment, and depreciation. Miscellaneous expenses include items such as legal and accounting fees, travel, advertising, and all other non-labour and non-capital expenses. Hourly wages and capital services are estimated at the firm level from Statistics Canada's sources. The size of the network is estimated by the number of brokers and agents affiliated with the insurance company; its rental cost is estimated as the ratio of commissions on premiums and annuity considerations to the size of the network.

Nominal output, net of reinsurance, is measured as premiums *less* claims *plus* investment income. The latter has been allocated by commodity line on the basis of the value of premiums earned. The information on the number of policies and certificates of life insurance and annuities collected from life insurance companies by OSFI allows the implicit price of these two commodity lines to be determined. The same information for P&C insurance is not available from the same sources. I therefore used the insurance components of consumer prices indices (automobile and property insurance) at the firm level. The combination of these two components is used as a substitute for the price of liability insurance as they both comprise a component of liability insurance.

I organized these data into a time series panel, thus making it possible not only to look at the structure of firms in a given year, but also to observe their development over time. The final sample consisted of 710 observations of P&C companies and 580 observations of life insurance companies, for which summary statistics are presented in Table I by type of business (life vs. non-life insurance). Regardless of the product line, multiproduct firms generally have more than $\frac{4}{5}$ of the market; however, this proportion does not seem to be constant over time from one product line to another with the important changes occurring in the P&C insurance industry. It is interesting to note that multiproduct firms increased their market share in the product lines that had the greatest growth rates, such as liability insurance and annuities. The fact that the market share of the monoproduct companies that were excluded from the sample changed from one period to the next and that there was a relatively high turnover rate among the multiproduct firms retained in the sample justifies taking selectivity bias into account in the estimation of short-run cost function parameters.

[Insert Table I here]

IV. Econometric Implementation

1. Econometric Issues

The short-run cost function $G(w,Y,N,A)$ is used to estimate the parameters underlying the technology and economic performance indicators of the insurance firm. The panel data set used is in essence incomplete as a result of the exclusion of monoproduct firms from the sample. Specifically, since I retained only multiproduct firms in the sample, the short-run cost function for a single firm can be stated as

$$G = \begin{cases} G(w,Y,N,A) + \omega & \text{iff } Y = (Y_1, Y_2, \ldots, Y_m) \\ 0 & \text{otherwise.} \end{cases} \qquad (6)$$

An estimation that ignores this distinction by fitting equation $G(w, Y, N, A)$ by ordinary least squares (OLS) technique using population subsamples that consist only of multiproduct firms results in a non-random selection of the errors term ω, since by (6), a firm will be included in the sample if and only if it operates under a multiproduct technology. Since observations are systematically selected into the estimation subsample according to the criterion $\omega > -G(w, Y, N, A)$, OLS parameter estimates based on such subsample do not provide consistent estimates of the short-run cost structure parameters. To correct for selectivity bias, I used a procedure developed by Heckman (1979) that involves an OLS estimation of an expanded short-run cost function $G(\cdot)$. The conditional expectation of multiproduct firms' short-run cost function can be written as

$$E\left(G^*(\cdot)\right) = E\left(G(\cdot) \middle| Y = \left(Y_1, Y_2, ..., Y_m\right)\right) = G(\cdot) + S$$

where $S = \sigma h$ (with $h \equiv \frac{f(g)}{F(g)}$) is the conditional mean of ω; $g \equiv \frac{G(\cdot)}{\sigma}$, $f(\cdot)$ is the unit normal density, and $F(\cdot)$ is the cumulative normal distribution function. Since S in the equation above is essentially an omitted variable in the restricted cost function model $G(\cdot)$, Heckman has suggested adding an estimate of h as a regressor to such an equation and then estimating the expanded regression equation by OLS while limiting the sample to multiproduct firms. He suggested the estimation of h initially on the basis of a probit regression using data from all firms and shows that when this estimate of h is appended as a regressor to the short-run cost function $G(\cdot)$, OLS estimates are consistent.

Since I am dealing with a pooled sample of firms, the issue of heterogeneity is an important one. Unobserved firms' heterogeneity that persists over time may introduce serial correlation and, although OLS parameter estimates remain consistent in this case, they are inefficient, and the estimated standard errors may induce a false sense of statistical significance. In my sample, heterogeneity can arise from two main sources: i) life insurance and P&C insurance firms can be expected to operate under different technologies and ii) within any business, firm-specific heterogeneity will exist because of differences in ownership and control.

These idiosyncratic effects are accounted for by estimating separately the short-run cost functions of life and non-life insurance firms. Differences in ownership and control are captured by the use of the intercept dummy variable D_W. $D_W = 1$ if the firm is a mutual company; otherwise, $D_W = 0$.

Given the technology $G(w, Y, N, A)$, a translog variable cost function is parametrized as a function of output Y, a measure of the network size (N), the prices of variable inputs (w_i), with $i = K$ (capital), L (labour), and M (intermediate inputs), an index of industry-wide technical change (A). This cost function has an important distinct feature from the one usually used in the sense that the standard time trend has been replaced with an unobserved general index of technical change A (Baltagi and Griffin 1988). The parametrization of the short-run cost function of a multiproduct firm $k\ (1,2,..,K)$ is

$$\begin{aligned} \ell nG_{kt} &= \alpha_o + \lambda_W D_W + A(t) + \alpha_h h + \sum_i \alpha_i \ell nw_i + \sum_s \gamma_s \ell nY_s + \phi_R(\ell nN) \\ &+ \tfrac{1}{2}\sum\sum \alpha_{ij}(\ell nw_i)(\ell nw_j) \sum_i \sum_s \alpha_{is}(\ell nw_i)(\ell nY_s) + \sum_i \alpha_{iA} \ell nw_i A(t) \\ &+ \sum_i \alpha_{iN}(\ell nw_i)(\ell nN) + \tfrac{1}{2}\sum_s \sum_{s'} \gamma_{s,s'}(\ell nY_s \ell nY_{s'}) + \tfrac{1}{2}\phi_{RR}(\ell nN)^2 \\ &+ \sum_s \gamma_{As} A(t)(\ell nY_s) + \phi_{AN} A(t)(\ell nN) + \sum_s \beta_{sN}(\ell ny_s)(\ell nN) + \xi_{kt}. \end{aligned} \qquad (7)$$

However, (7) raises two major problems: First, t he panel data set of multiproduct firms used is, in essence, incomplete as a result of insurers' turnover in terms of entry/exit. The use of a balanced panel raises the possibility of selectivity bias since new firms (those that opened during 1985-1995) and unsuccessful firms (those that closed during the same period) are systematically excluded from this panel. As emphasized by Olley and Pakes (1991), this exclusion may bias the estimates of the cost function parameters. The results in terms of economic performance indicators may also be biased. For example, technical change as measured by a shift in the cost function may be erroneously due to changes in the sample of firms over time. Second, the estimation of (7) would be a simple matter if only $A(t)$ were observable. However, using time-specific dummy variables D_t $(t = 1,2,...,T)$ and a pooled data set, I estimated (7) together with two of the corresponding three share equations (see Baltagi and Griffin 1988; Dionne and Gagné 1992)

$$\begin{aligned}\ell nG_{kt} = {} & \lambda_W D_W + \sum_t \eta_t D_t + \alpha_h h + \sum_s \sum_t \gamma_{s,t} (\ell nY_s) D_t + \sum_t \phi_{Nt} (\ell nN) D_t + \sum_i \sum_t \alpha^*_{it} (\ell nw_i) D_t \\ & + \tfrac{1}{2} \sum_i \sum_j \alpha_{ij} (\ell nw_i)(\ell nw_j) + \sum_i \sum_s \alpha_{i,s} (\ell nw_i)(\ell nY_s) + \sum_i \alpha_{iY} (\ell nw_i)(\ell nN) \\ & + \tfrac{1}{2} \sum_s \sum_{s'} \gamma_{ss'} (\ell nY_s)(\ell nY_{s'}) + \tfrac{1}{2} \phi_{NN} (\ell nN)^2 + \sum_s \beta_{sN} (\ell nY_s)(\ell nN) + \xi_{kt},\end{aligned} \tag{8}$$

and

$$S_i = \sum_t \alpha^*_{it} D_t + \sum_j \alpha_{ij} (\ell nw_j) + \sum_s \alpha_{is} (\ell nY_s) + \alpha_{iN} (\ell nN) + \mu_{kt}. \tag{9}$$

Equations (8) and (9) are identical to the parameters in (7) if and only if

$$\begin{aligned}\eta_t &= \alpha_o + A(t) + \pi(t)DE(t) + \psi(t)DX(t) \\ \alpha^*_{it} &= \alpha_i + \alpha_{iA}[A(t) + \pi(t)DE(t) + \psi(t)DX(t)] \\ \gamma_{st} &= \gamma_s + \gamma_{As}[A(t) + \pi(t)DE(t) + \psi(t)DX(t)] \\ \phi_{Nt} &= \phi_N + \phi_{AN}[A(t) + \pi(t)DE(t) + \psi(t)DX(t)],\end{aligned} \tag{10}$$

where the dummy variables $DE(t)$ and $DX(t)$ capture the turnover that occurs in the financial intermediation activity of insurance companies. $DE(t) = 1$ if the firm is not in the sample in $t-1$; otherwise, $DE(t) = 0$. $DX(t) = 1$ if the firm unit is not in the sample in $t+1$; otherwise, $DX(t) = 0$.

Estimates of $A(t)$, the industry-wide measure of pure technical change, can be derived by imposing the restrictions in (10) on the system of equations (8) and (9). This can be implemented by using the non-linear iterated seemingly unrelated regression procedure. Furthermore, taking the initial year as the base year for $A(t)$ (i.e., $A(1) = 0$) and assuming that entry/exit will not occur in the first and last periods, i.e. $\pi(1) = \pi(T) = \psi(1) = \psi(T) = 0$, allow me to identify $\alpha_o, \alpha_i, \gamma_s, \phi_N, \pi(t), \psi(t)$ as well as the index $A(t)$.

2. Other Economic Performance Indicators

By subjecting the estimation of the parameters in (8) and (9) to (10), it is possible to compute the rate of technical change as $\dot{T}$:

$$\dot{T} \equiv \frac{\dot{B}}{B} = A(t) - A(t-1) + \sum_s \gamma_{As} \ell n Y_s \left[A(t) - A(t-1)\right] + \left(\sum_i \alpha_{iA} \ell n w_j + \phi_{AR} \ell n N\right)\left[A(t) - A(t-1)\right]. \quad (10)$$

The approach suggested by (10) does not impose the restriction that pure technical change will change at a constant rate. Note that year-to-year changes in the estimates of $A(t)$ may even provide a very erratic pattern of technical change, reflecting the effects of technological epochs. In turn, technical change can be broken down into the following three components: i) the effects of pure technical change $[A(t)-A(t-1)]$, ii) the effects of scale augmentation $\sum \gamma_{AY_s}[A(t)-A(t-1)]\ell n Y_s$, and iii) the effects of non-neutral technical change $\left(\sum_j \alpha_{jA} \ell n w_j + \phi_{AN} \ell n N\right)[A(t)-A(t-1)]$.

The inclusion of N along with the vector of output (and other variables) enables me to account for the network effect. It is particularly important to make this distinction for firms in which services are provided over a network of spatially distributed points as cost per unit of output may vary among firms depending on the nature of their network served. Previous studies introduced the network effect in the specification of the banking industry; the application of this effect to the activity of insurance firms, which also manage a substantial network of brokers and agents, seems an obvious extension.

Returns to scales (RTS) adjusted for the benefits generated by the existence of a network are measured as (see Caves et al. 1981)

$$RTS = \frac{\left(1-\varepsilon_{G,N}\right)}{\sum_s \varepsilon_{G,Y_s}},$$

where

$$\varepsilon_{G,Y_s} = \sum_t \left\{\gamma_s + \gamma_{As}\left[A(t) + \pi(t)DE(t) + \psi(t)DX(t)\right]\right\}D_t + \gamma_{s'}\left(\ell nY_{s'}\right) \\ +\sum_t \alpha_{is}\left(\ell nw_i\right) + \beta_{sN}\left(\ell nN\right). \tag{11a}$$

and

$$\varepsilon_{G,N} = \sum_t \left\{\phi_N + \phi_{AN}\left[A(t) + \pi(t)DE(t) + \psi(t)DX(t)\right]\right\}D_t \\ +\sum_i \alpha_{iN}\ell nw_i + \phi_{NN}\ell nN + \sum_s \beta_{sN}\gamma_s\left(\ell nY_s\right) \tag{11b}$$

where $\varepsilon_{G,N}$ captures the returns to network expressed in terms of cost-savings elasticity, ε_{G,Y_s} is the output-specific cost elasticity, and $\sum_s \varepsilon_{G,Y_s}$ is the overall cost elasticity of output. Returns to scale are said to be increasing, constant, or decreasing when RTS is greater than unity, equal to unity, or less than unity, respectively.

Additional insights into the economic performance indicators are provided by examining economies of scope or interproduct complementarities, which indicate whether it is more efficient to produce the outputs vector together or to produce it by separate production units. The degree of global economies of scope (GES) is measured as $GES = \frac{\left[G(Y_1)+G(Y_2)+G(Y_3)-G(Y)\right]}{G(Y)}$ where $GES > 0$, indicating that joint production is more efficient than otherwise and its magnitude measures the cost-savings from joint production. A closer look at the cost complementarity may be obtained from product-specific economies of scope $\left(PES_j\right)$ defined as $PES_1 = \frac{\left[G(Y_1,Y_2)+G(Y_3)-G(Y)\right]}{G(Y)}$, where $PES_1 > 0$ indicates the proportional increase in costs from separating output 1 from the production of other services.

V. Empirical Results

1. Parameter Estimates and Restrictions Tests

With a data set consisting of 710 observations on non-life insurance companies and 580 observations on life insurance companies for the period 1985-1995, an iterative Zellner efficient estimation procedure was used on a system of a variable cost function and two cost shares (labour and materials with the capital share excluded). The parameter of both types of businesses were estimated separately for the general model (equations (8) and (9)). The results are displayed in Tables II. The standard tests for a well-behaved cost function were supportive. The results of symmetry and concavity were not rejected. Homogeneity, however, was rejected for P&C insurance only; nonetheless, it was imposed. As noted earlier, the exclusion of multiproduct firms from the sample raises the issue of sample selection bias, which occurs if the excluded firms differed systematically in their cost characteristics from the included ones. Sample selection bias was therefore investigated by testing that the inverse Mill's ratio α_h was significantly different from zero. As shown by Tables II, the results suggest that the variable h captures the otherwise missing information related to the excluded non-multiproduct firms.

[Insert Table II here]

The majority of the parameters in the estimated cost function are significant at conventional levels and have the expected sign. The heterogeneity dummy control variable λ_W is significant for both types of businesses and suggests that mutual life insurance companies are more efficient than the reference case and vice versa for non-life insurance companies. This represents a rejection in part of the main prediction of prevailing economic theories of organizations, which argues that because of impediments to monitoring managers' activities, mutual insurance companies may be less efficient than stock insurance companies (see Fama and Jensen 1985; Mayers and Smith 1988).

The results of the hypothesis tests using log-likelihood ratios are shown in Table III. Sample selection bias related to the entry/exit of multiproduct firms was investigated by testing the hypothesis $\pi(t) = \psi(t) = 0$ for $t = 2,3,\ldots,T-1$. The results indicate that this hypothesis is readily rejected at less than one percent, which suggests that the selectivity bias that may result from entry / exist is an important issue in my sample. The likelihood ratio tests suggest a decisive rejection of the joint hypothesis that the coefficients related to the network are zero, suggesting that this variable is meaningful in explaining the cost structure of insurance companies. Also, the hypothesis that insurance companies have not experienced technical progress of any kind was decisively rejected.

[Insert Table III here]

A further description of the production structure is provided by the Allen-Uzawa partial elasticities of substitution and elasticities of demand. The entries in Table IV indicate that for life and non-life insurance companies all own-price elasticities are negative and statistically significant, a necessary condition for the cost-minimizing factor-demand theory. The inputs can be ranked in the following order of declining (in absolute value) price elasticity of demand: intermediate inputs are by far more elastic than labour. With an elasticity of less than 0.05, labour is the input whose own-price elasticity is the most inelastic. With regard to the elasticities of substitution, the entries in Table IV indicate that labour and intermediate inputs are substitutes and that both of them have a negative effect on the shadow price of the network.

[Insert Table IV here]

2. Estimates of Economies of Scales and Scope

As previously discussed, in industries where firm size has two dimensions —that of the service network and that of the magnitude of services —the interpretation of scale economies is different from the conventional measure that uses the cost elasticity of output. In fact, the inverse of the cost elasticity of output cannot be interpreted as a measure of returns to scales (RTSs). Using the parameters reported in Table II, RTSs were estimated. To provide insights into the groups' cost characteristics over a reasonable range of the industry cost manifold, estimates of RTSs were also derived for quartile sample output vectors. The quartile sample mean output vectors were formed by ranking each output by type of business (life and non-life insurance). These estimates were compared with those of returns to scale where network effects are constrained to be zero (CRTS).

The results in Table V indicate that, for the overall sample mean output vector, all types of businesses exhibit statistically significant CRTSs. The average CRTSs for life insurance companies and P&C insurance companies are 1.08 and 1.02 respectively, which do not appear to be significantly different. This clearly suggests that, in the absence of network effects, both life insurance and non-life insurance businesses operate under constant RTSs. But the results show that the CRTSs estimates vary substantially between the fourth output quartile and the first quartile. For example, life and non-life insurance companies in the first quartile exhibit relatively high and statistically significant CRTSs. By contrast, the hypothesis of constant CRTSs cannot be rejected for these companies in the fourth quartile. With regard to interbusiness comparisons, the results show that, in general, life insurance companies display higher CRTSs than do their non-life counterparts. This suggests that, unlike their life insurance counterparts, non-life insurance companies incur higher incremental costs.

[Insert Table V here]

By definition, the higher the cost-savings attributed to the availability of a network ($\varepsilon_{G,N} < 0$), the higher the RTS. The results in Table V show that, for the overall sample, mean output vectors of large firms exhibit statistically significant RTS economies. The average of the RTSs for life insurance companies is 1.49, and that of non-life insurance companies is 1.30. However, there are significant differences in terms of RTSs between life and non-life insurance companies. Since they are significant RTSs, this implies that a non-parametric estimate of TFP may be a poor approximation of technical progress. Remarkably, although CRTSs benefit mostly firms in the first and second quartiles, the cost-savings generated by the presence of the network allows large life and non-life insurance companies (those in the third and fourth quartiles) to display important economies of scales.

Analysis of economies of scope in the joint production of outputs provides insight into the cost-savings from jointly producing insurance services relative to producing each service individually. From the estimates in Table V, it appears that, on average, there are global economies of scope for both life and non-life insurance companies. Specifically, joint production is estimated to account for up to 20 percent of cost-savings. Interestingly, for both types of businesses, these savings become smaller as they move from the first to the last output quartile. In the case of non-life insurance, however, the results indicate that product-specific economies of scope exist for each type of service but do not exceed 9.6 percent on average. Overall, the results suggest that, for non-life insurance companies, greater savings can be achieved from the combination of all outputs as opposed to the combination of one output with an existing output.

In summary, the empirical evidence suggests that, while CRTSs and cost-savings complementarities are generally exhausted for the largest insurance firms, the existence of substantial cost-savings generated by a network effect allows large firms to display higher economies of scale. These results hold for both life and non-life insurance companies. In addition, cost-savings from jointly producing insurance services as opposed to individually producing each service are larger for small and medium-sized firms, but they have the tendency to be exhausted in the case of larger firms.

3. Estimates of Total Factor Productivity

Firms estimates of productivity growth were developed and then weighted as a share of industry output to produce industry-level estimates of TFP and its breakdown into technical change, scale economies, price-cost margin, and temporary equilibrium effect. In Table VI, life insurance companies' TFP growth was found to increase at an average annual rate of 2.6 percent for the period 1985-1995. From 1985 to 1990, TFP grew at an average annual rate of roughly 3.4 percent. For the 1990-1993 period, a slight decline (only 2.1 percent) was detected in the TFP growth, reflecting the effect of the business cycle. A slight recovery in the TFP growth rate was noticeable during the subsequent recovery period (2.3 percent).

[Insert Table VI here]

It is of interest to see whether there are identifiable patterns of TFP between life and non-life insurance companies. Inspection of entries in Table VI indicates that, on average, life insurance companies enjoyed higher productivity growth than their non-life counterparts. With an average annual growth of TFP as low as 0.8 percent, non-life insurance companies displayed an anemic productivity growth. As for life insurance companies, most of the TFP growth took place during the period of economic growth. [4] During the period for which estimates of the productivity of goods-producing industries and non-financial services industries are comparable, [5] that is 1985-1992, the TFP of life and non-life insurance business grew, respectively, at an average annual rate of growth of 2.6% and .81%, compared with a negative annual average rate of 0.39% for goods-producing industries and 0.48% for non-financial services producing industries.

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[4] This result is in part due to the use of inappropriate deflators of non-life insurance output. Since the value of insurance services considered in the non-life insurance component of the CPI are constructed on the basis of the value of premiums (instead of premiums *less* claims *plus* investment income), this has a tendency to overestimate the non-life insurance component of the CPI, which results in an underestimation of my non-life insurance output.

[5] See Statistics Canada (1996).

As noted in (10), the estimated technical change index can in turn be broken down into the effects caused by pure technical change, non-neutral technical change, and scale-augmenting technical change. Table VI provides the results of this breakdown for both life and non-life insurance companies for selected time intervals. At 80 percent and 66 percent on average for life and non-life, respectively, scale-augmenting technical change was the most important component of technical change. It is followed well behind by non-neutral technical change (18 percent and 34 percent, respectively, for life and non-life insurance).

The fact that life insurance companies' scale-augmenting technical change contribution to technical change is higher than that of their non-life counterparts may be related to government policy and the product innovations that have taken place during the last two decades in the life insurance business. Government tax policy has had a profound effect on life insurance companies' product mix. Apart from a shift in product demand caused by tax changes (see Burbidge and Davies 1994), there has been a pronounced trend away from whole life policies and toward term insurance. Policies that have encouraged savings through tax-sheltered RRSPs have increased the demand for annuities. A large portion of each dollar of whole life insurance premiums (compared with term insurance premiums for example) is retained for the acquisition of assets because whole life insurance, especially in a policy's early years, contains a significant savings component. Similarly, each dollar of deferred annuity premiums goes almost entirely to acquire assets, which may be held for many years before liquidation. In this sense, the change of life insurers' products influences the growth of this business.

The results displayed in Table VI show that scale economies have contributed to more than 60 percent of insurance companies' TFP growth. However, this contribution has been slightly declining for both life and non-life insurance companies. The effect of market structures represents the third major component of TFP growth after economies of scale and technical change. However, the contribution of market structures to TFP growth is twice as high for non-life insurance as it is for life insurance. There is evidence of imperfect competition in the insurance business, particularly in the non-life insurance industry, as suggested by a non-negligible contribution or price-cost margin to TFP growth. Problems of information asymmetry in favour of the buyer may force firms to charge higher prices to high-risk individuals.

Although the network size has experienced a positive, albeit small, year-over-year growth rate, the effect of temporary equilibrium on TFP growth has experienced three distinct trends during the 1985-1995 period. Although the effect of temporary equilibrium was positive during the subperiod 1985-1990, it became negative in the subsequent periods. The procyclical feature of the temporary equilibrium effect mainly suggests that the long-run hypothesis underlying the non-parametric TFP framework has been violated. A casual comparison of the estimated value of the shadow price of network z with its market price r suggests that, for the earlier years of the period 1985-1990, there was a strong incentive for network investment, which ultimately led the industry to use the network to full capacity.[6] This trend was slightly reversed during the 1990-1993 subperiod as the economy entered a recession, during which there was an apparent excess capacity level of network. The incentive for additional network investment fell during this period, however it increased slightly in the subsequent period as the economy entered a period of recovey.

To provide insight on how company size may effect TFP, estimates of TFP were also derived for the quartile sample output of life and non-life insurance companies. Examination of the estimates of TFP growth for the quartile output reveals a consistent pattern with other economic performance indicators such as the constrained returns to scale and economies of scope. Chart 1, which plots TFP for life and non-life insurance firms, shows a consistent pattern across quartiles.

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[6] During the period 1985-1991, the ratio q had an average annual growth rate of 18.3 percent for life insurance and 12.1 percent for non-life insurance companies. Thereafter, it started to decrease to 7.4 percent and 11.2 percent, respectively.

Although TFP growth tends to decline as the size of the insurance firm, productivity gains do not appear to be fully exhausted for large life insurance firms.

[Insert Chart 1 here]

VI. Conclusion

With the proliferation of information technology over the past several decades, networks have become increasingly important. Examples include banks' automated teller machines, airlines' reservation systems, and the increased use of the Internet. Although networks have been shown to have important implications on firms' strategies for product announcement, technology adoption, and pricing (see Katz and Shapiro 1985), there has been no attempt to measure the effects of networks on firms' cost structures.

In this paper, a short-run cost function defined over a vector of output and the size of insurance companies' network was specified and estimated for an incomplete panel data set of Canadian life and non-life insurance companies. RTSs were found to be large and statistically significant, particularly for large insurance companies, as cost-savings associated with the existence of a network of agents and brokers allows large firms to exhibit increasing returns to scale in the short run. Failure to account for network effects has led many previous studies using different national data to conclude that large firms operate under constant RTSs.

Changes in TFP through time are hypothesized to be the result of scale economies, technical change, market structures, and the temporary equilibrium associated with the existence of a network with a given size in the short run. The findings indicate that although life insurance companies out perform their non-life counterparts in terms of TFP growth, the bulk of this growth for both types of firms is a result of scale economies and technical change. There is evidence of imperfect competition in the insurance business, particularly in the non-life insurance industry, as suggested by a non-negligible contribution or price-cost margin to TFP growth. Problems of information asymmetry in favour of the buyer may force firms to charge higher prices to high-risk individuals.

There is strong evidence that the long-run hypothesis underlying the non-parametric TFP framework has been violated. The results suggest that, in general, the level of various economic performance indicators declines with the firm size. This indicates that, unlike medium-sized firms, large ones have exhausted their potential for economic performance. Although there are variants across businesses, this result holds for both life and non-life insurance companies.

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Table I. Summary Statistics Based on Nominal Output (in $ millions)

	1985			1995		
Non-Life Insurance	**Property**	**Auto**	**Liability**	**Property**	**Auto**	**Liability**
All firms (1)	1,819	2,219	469	2,892	4,251	832
Multiproduct firms (2)	1,624	2,038	421	2,383	3,613	764
(2) ÷ (1) in %	89.3	91.8	89.8	82.4	85.0	91.8
Life Insurance	**Life insurance**		**Annuities**	**Life insurance**		**Annuities**
All firms (1)	2,723		3,934	5,070		7,772
Multiproduct firms (2)	2,338		3,511	4,264		7,208
(2) ÷ (1) in %	85.9		89.2	84.1		92.7
	Life Insurance			Non-Life Insurance		
Turnover Rate (in %) [a] (1985-1995)	11.7			28.1		

Note: [a] Sum of absolute value of changes in output over the period (output of entrants *plus* output of exiters) over the total output.

Table IIa. Parameter Estimates of Life Insurance Companies' Short-Run Cost Function with a General Index of Technical Change

Variable	Estimate	$t-$statistic	Variable	Estimate	$t-$statistic
α_o	3.0512	2.113	$\pi(86)$	0.0912	1.611
α_L	0.2214	3.710	$\pi(87)$	0.0312	1.809
α_M	0.1296	2.811	$\pi(88)$	0.0102	1.611
γ_{Y_L}	0.1081	3.126	$\pi(89)$	0.0512	1.987
γ_{Y_A}	0.2342	5.234	$\pi(90)$	0.1012	2.876
ϕ_N	0.2813	2.313	$\pi(91)$	0.0399	2.011
α_{LL}	0.1511	2.411	$\pi(92)$	0.0093	1.311
α_{MM}	0.0512	1.934	$\pi(93)$	0.0023	1.098
α_{LM}	-0.0113	2.915	$\pi(94)$	0.0102	1.134
α_{LY_L}	0.0912	2.981	$\psi(86)$	-0.0198	1.013
α_{LY_A}	0.1123	2.673	$\psi(87)$	-0.0145	1.997
α_{MY_L}	-0.0221	1.875	$\psi(88)$	-0.0449	2.018
α_{MY_A}	-0.0102	1.773	$\psi(89)$	-0.0711	2.012
α_{LA}	0.0051	2.121	$\psi(90)$	-0.1298	1.978
α_{MA}	-0.0155	2.127	$\psi(91)$	-0.0823	3.129
α_{LN}	0.0114	2.174	$\psi(92)$	-0.4412	3.129
α_{MN}	0.0128	2.861	$\psi(93)$	-0.4012	2.455
$\gamma_{Y_LY_L}$	0.2312	3.481	$\psi(94)$	-0.3866	2.523
$\gamma_{Y_AY_A}$	0.3581	4.534	$A(86)$	-0.1011	2.011
$\gamma_{Y_LY_A}$	0.0871	2.012	$A(87)$	-0.0978	2.801
ϕ_{NN}	-0.2253	2.413	$A(88)$	-0.0489	3.912
γ_{AY_L}	0.0124	3.167	$A(89)$	-0.0712	2.012
γ_{AY_A}	0.1131	5.234	$A(90)$	-0.1123	3.123
ϕ_{AN}	0.0923	2.451	$A(90)$	-0.1123	3.123
β_{Y_LN}	0.2192	5.221	$A(91)$	-0.1245	3.891
β_{Y_AN}	0.3381	3.819	$A(92)$	-0.0778	5.897
λ_W	-0.0812	2.871	$A(93)$	-0.0983	3.089
α_h	1.310	4.023	$A(94)$	-0.1377	4.912
			$A(95)$	-0.1012	3.091

Equation	**Std. Error**	R^2
Cost	0.06156	0.94
Labour Share	0.02267	0.87
Intermediate Input Share	0.01912	0.84
Log of Likelihood	2,723	

Table IIb. Parameter Estimates of Non-Life Insurance Companies' Short-Run Cost Function with a General Index of Technical Change

Variable	Estimate	$t-$statistic	Variable	Estimate	$t-$statistic
α_o	0.0102	3.467	$\beta_{Y_A N}$	0.0123	1.667
α_L	0.1169	1.982	$\beta_{Y_L N}$	0.1711	3.123
α_M	0.0914	1.758	λ_W	0.1226	4.121
γ_{Y_P}	0.0774	4.125	α_h	2.017	3.148
γ_{Y_A}	0.1281	3.339	$\pi(86)$	0.0107	1.981
γ_{Y_L}	0.2341	4.181	$\pi(87)$	0.0212	2.016
ϕ_N	0.3112	4.167	$\pi(88)$	0.0314	3.117
α_{LL}	0.0912	1.912	$\pi(89)$	0.0174	3.339
α_{MM}	0.0417	2.012	$\pi(90)$	0.0471	4.125
α_{LM}	-0.0221	1.698	$\pi(91)$	0.0701	1.974
α_{LY_P}	0.0152	1.711	$\pi(92)$	0.0093	2.447
α_{LY_A}	0.0781	1.991	$\pi(93)$	0.0023	0.557
α_{LY_L}	0.1023	3.012	$\pi(94)$	0.0097	2.007
α_{MY_P}	-0.0981	1.814	$\psi(86)$	-0.0077	1.147
α_{MY_A}	-0.0114	2.115	$\psi(87)$	-0.0142	2.227
α_{MY_L}	-0.1098	3.119	$\psi(88)$	-0.0314	1.781
α_{LA}	0.0088	3.874	$\psi(89)$	-0.0591	3.227
α_{MA}	-0.0978	1.689	$\psi(90)$	-0.0798	4.126
α_{LN}	0.0447	1.978	$\psi(91)$	-0.0516	2.474
α_{MN}	0.0011	1.551	$\psi(92)$	-0.1293	2.987
$\gamma_{Y_P Y_P}$	0.1102	1.997	$\psi(93)$	-0.1147	3.074
$\gamma_{Y_A Y_A}$	0.1477	2.411	$\psi(94)$	-0.0071	2.851
$\gamma_{Y_L Y_L}$	0.1827	2.866	$A(86)$	-0.0367	3.157
$\gamma_{Y_P Y_A}$	0.0275	1.886	$A(87)$	-0.0407	1.889
$\gamma_{Y_P Y_L}$	0.0981	2.113	$A(88)$	-0.0566	2.471
$\gamma_{Y_A Y_L}$	0.1366	4.129	$A(89)$	-0.0889	9.771
ϕ_{NN}	-0.1652	4.336	$A(90)$	-0.1202	2.971
γ_{AY_P}	0.0234	2.110	$A(90)$	-0.1011	2.339
γ_{AY_A}	0.0761	1.997	$A(91)$	-0.0833	4.117
γ_{AY_L}	0.1183	4.125	$A(92)$	-0.0519	2.997
ϕ_{AN}	0.07112	3.667	$A(93)$	-0.0711	2.339
$\beta_{Y_P N}$	0.0543	1.714	$A(94)$	-0.1209	5.971
			$A(95)$	-0.1488	2.789

Equation	**Std. Error**	R^2
Cost	0.09367	0.89
Labour Share	0.05147	0.84
Intermediate Input Share	0.02204	0.81
Log of Likelihood	2,507	

Table III. Hypothesis Testing

Parameter Restrictions	Log of Likelihood	χ^2	Degrees of Freedom
Life Insurance			
$\pi(\boldsymbol{t})' = \psi(\boldsymbol{t})' = \mathbf{0}$	2,568	141	18
$\phi_N = \alpha_{LN} = \alpha_{MN} = \phi_{NN} = \phi_{AN} = \beta_{Y_L N} = \beta_{Y_A N} = 0$	2,011	179	7
$A(t)' = \mathbf{0}$	1,837	143	10
Non-Life Insurance			
$\pi(\boldsymbol{t})' = \psi(\boldsymbol{t})' = \mathbf{0}$	2,125	155	18
$\phi_N = \alpha_{LN} = \alpha_{MN} = \phi_{NN} = \phi_{AN} = \beta_{Y_P N} = \beta_{Y_A N} = \beta_{Y_L N} = 0$	2,097	188	8
$A(t)' = \mathbf{0}$	1,785	145	10

Note: The critical values χ^2 with 7, 8, 10 and 18 degrees of freedom at less than 1 percent level of signicance are 20.28, 21.96, 25.19, and 37.16, respectively. The symbol «'» designates a vector of parameters.

Table IV. Own Price and Elasticities of Substitution
(t – statistic in parentheses)

	Labour	**Intermediate Inputs**	**Network**
Life Insurance			
Labour	-0.056 (2.967)	-0.557 (3.885)	-0.031 (2.223)
Intermediate Inputs		-0.559 (2.414)	-0.085 (2.671)
Network			-0.331 (6.129)
Non-Life Insurance			
Labour	-0.041 (2.008)	-0.667 (1.978)	-0.091 (4.119)
Intermediate Inputs		-0.338 (1.844)	0.054 (1.774)
Network			-0.265 (2.558)

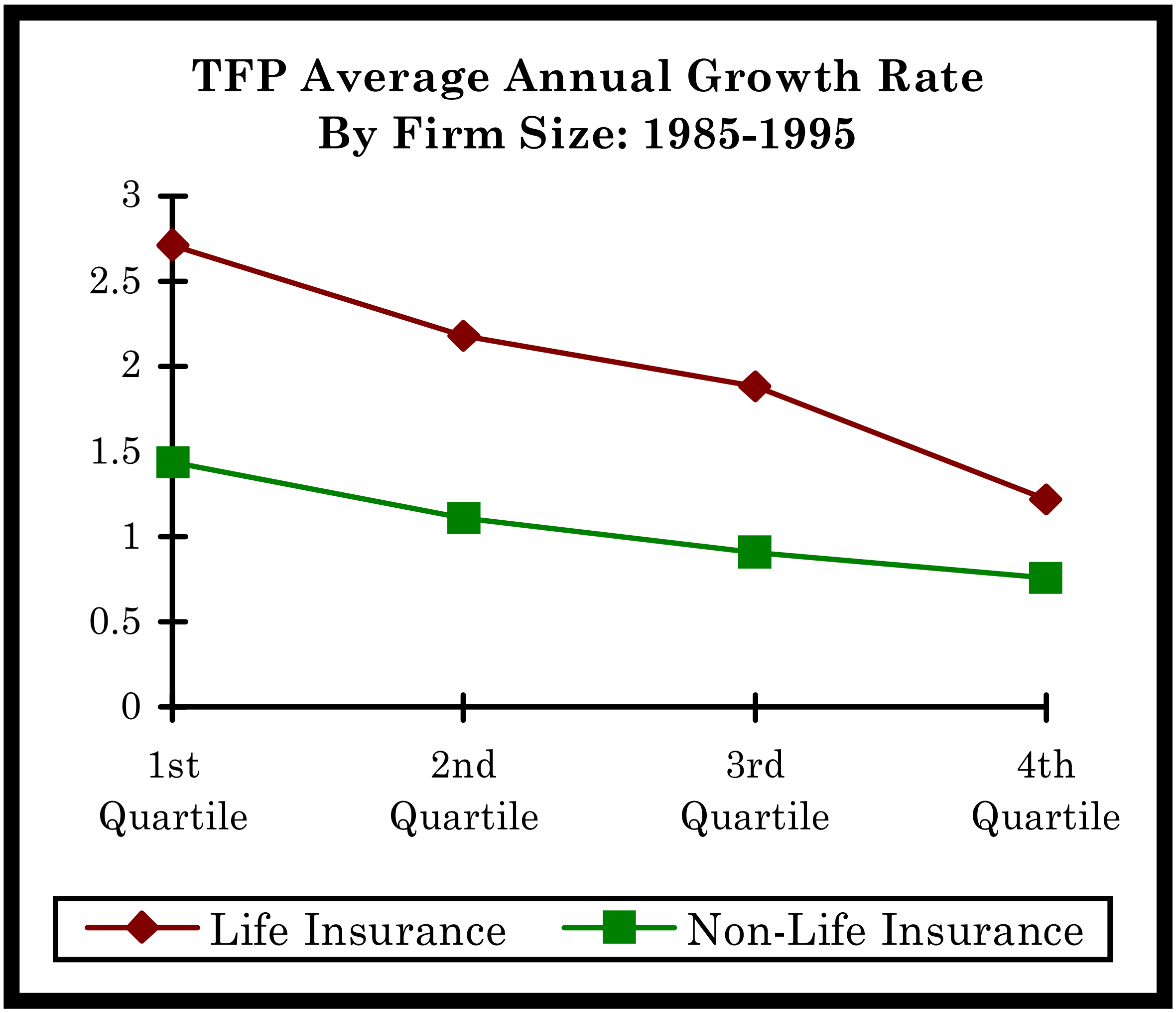
Table V. Estimates of Returns to Scale and Returns to Scope by Quartile and by Type of Business (Asymptotic standard errors in parenthesis)

Type of Business and Ownership	Overall	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Constrained Returns to Scale[a]					
Life insurance	1.08	1.18	1.21	1.05	1.02
Non-life insurance	1.02	1.12	1.16	1.03	1.01
Returns to Scale					
Life insurance	1.49	1.39	1.38	1.45	1.54
Non-life insurance	1.30	1.24	1.24	1.36	1.48
Economies of Scope					
Life Insurance					
GES	.271	.345	.272	.163	.087
Non-Life Insurance					
GES	.219	.236	.221	.114	.111
PES (Property)	.061	.094	.081	.063	.055
PES (Auto)	.096	.124	.103	.082	.063
PES (Liability)	.074	.131	.084	.065	.044

Note: [a] It is a measure of returns to scale where the effect of network is constrained to be zero; all estimates are significant at least at the 5 percent level of significance; *GES* = global economies of scope, *PES* = product-specific economies of scope.

Table VI. Total Factor Productivity Growth and Its Sources

Time Period	TFP in %	Percentage Contribution to TFP of: Non-Constant Returns to Scale	Technical Progress: $\dot{T}$	Technical Progress: Pure	Technical Progress: Scale augmentation	Technical Progress: Non-neutral	Temporary Equilibrium	Price-Cost Margin
Life Insurance								
1985-1990	3.4	74.5	18.4	3.5	83.8	12.7	0.5	6.6
1990-1993	2.1	71.2	24.7	3.4	78.1	18.5	-3.1	7.2
1993-1995	2.3	69.5	28.5	1.4	76.5	22.1	-2.9	4.9
Average	**2.6**	**71.7**	**23.8**	**2.8**	**79.5**	**17.8**	**-1.8**	**6.2**
Non-Life Insurance								
1985-1990	.91	70.1	14.1	.5	70.4	29.1	4.1	11.7
1990-1993	.73	62.0	25.2	1.9	63.9	34.2	-1.4	14.2
1993-1995	.79	56.9	28.5	.5	61.2	38.3	-1.1	15.7
Average	**.81**	**63.0**	**22.6**	**.97**	**65.2**	**33.9**	**.53**	**13.9**


TFP Average Annual Growth Rate
By Firm Size: 1985-1995
3
2.5
2
1.5
1
0.5
0
1st Quartile
2nd Quartile
3rd Quartile
4th Quartile
Life Insurance
Non-Life Insurance