Measuring the Productivity of the Insurance Business at the Firm Level*

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Abstract: This paper applies a short-run production framework to the modeling of multifactor productivity in the Canadian insurance business. The measured multifactor productivity allows for the distinction between i) scale economies, ii) network effect, iii) market structures, and iv) technological change. Based on an incomplete panel data set at the firm level and a methodology that accounts for selectivity bias, the results suggest that multifactor productivity grew at an average annual growth rate of 1.0 percent during the 1985-2000 period. Scale economies represent the major component of these multifactor productivity growth rates, followed by technological change, market structures and the temporary equilibrium effect. In general, the productivity growth rate declines with the firm size. This suggests that, unlike small-medium size firms, large ones may have reached a technological frontier in which the sources of earlier rapid productivity growth start to be exhausted. While there are variants across businesses, this result holds form both life and non-life insurance companies.

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I. Introduction

Recent developments of intermediaries and the increasing importance of financial services in the economy has focused attention on the activities of financial intermediaries. In many countries, among these financial intermediaries, insurance companies account for a substantial share, second after commercial banks. In Canada, the insurance business is an important component of the financial services sector, with $200 billion of assets and $31 billion of output in 2000. The industry is notorious for its role as a conduit for savings of all kinds, and in the last decades has experienced a series of changes. The emergence of new competitive pressure resulting from a rapidly changing environment have raised concerns about their competitive viability in an increasingly deregulated market place.[1] However, except for studies of economies of scale (and recently of scope) little attention has been given to the general area of productivity in the insurance business as whole, a valuable indicator of economic performance.[2] It is the purpose of this paper to fill this gap.

The measurement of multifactor productivity growth is important for its own right, and it is even more important when juxtaposed on the following four stylized facts that marked the evolution of the insurance business: First, some product lines provided by this business have experienced a remarkable growth that far outpaced the growth of the economy. Changes in the product mix, illustrated by a pronounced shift away from life insurance toward annuities, have also taken place either as a result of the changes in the economic environment or government policy.

Second, most of the insurance markets display a high degree of concentration which tended to increase over time mainly as a result of the

[1]While banks are not allowed, under the Bank Act, to underwrite insurance directly, they have been allowed, through the 1987 amendments, to own insurance companies and to facilitate their clients applying for certain insurance coverage—a provision which has increased competition within insurance markets. Similarly, other financial intermediaries have entered banking by forming subsidiaries as schedule II banks including, but not limited to, the *Mouvement Desjardins* which owns the Laurentian Bank, Manufacturers Life which owns Manulife Bank and VanCity Credit Union which has applied to form a 'virtual bank' to service those inclined to do their banking on the Internet.

turbulence in terms of entry and exit. The combination of a large number of firms that exited the industry over the last decade and the growth experienced by certain markets over the same period allowed the largest insurance companies to increase their market shares. Third, the insurance industry is considered as a pioneer in the financial services industries because it is 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 the efficiency of insurance activities. Fourth, there are also reasons to believe that, due to the very nature of insurance activity, a significant portion of the inputs are represented by the retail activity network, a quasi-fixed input in the short run. An insurance firm requires the use of a network of agents and brokers to provide retail services to policyholders (sell insurance policies, provide information, etc.). It is particularly important to account for the network effect of insurance 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.

Measurement of cost changes and productivity gains must take these four stylized facts 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 by measuring multifactor productivity in the Canadian insurance business during the period 1985-2000. This incomplete panel data set results from the use of only multiproduct firms which 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

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

Dionne and Gagné (1996) to an incomplete panel data set. The measurement framework is broken down into its main component: 1) scale economies, 2) market structures, 3) temporary equilibrium, and 4) technological change. It is applied to life and non-life insurance companies operating in Canada as an illustration.

Overall, for the 1985-2000 period, the multifactor productivity of the insurance industry grew, respectively, at an enviable average annual rate of 1.0 percent. Scale economies represent the major component of these multifactor productivity growth rates, followed by technological change, market structures and the temporary equilibrium effect. The results suggest that, in general, the productivity growth rate declines with the firm size. This suggests that, unlike small-medium size firms, large ones may have reached a technological frontier in which the sources of earlier rapid productivity growth start to be exhausted. While there are variants across businesses, this result holds form both life and non-life insurance companies.

The remainder of the paper is organized as follows: Section II outlines the multifactor 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 multifactor productivity 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 such as 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.). It is particularly important to account for the network effect for insurers where 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. The benefit of access to a market wherever this happens to be means that the value of the agency/brokerage network of an insurance company increases in the number of brokers/agents locations it includes. An insurance firm can increase its network size by adding more agency offices to its proprietary system or by contracting the sale of its services through independent brokers.

The quasi-fixed nature of the network follows from the significant adjustment costs and the time required to dismantle or significantly alter the size of this input. 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.

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

2. The Multifactor Productivity Framework

Production theory models based on duality theory have been shown to be a rich framework for analysis of firms' technology and behaviour (see Morrison 1999 for a nice overview). 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 multifactor productivity measurement under the assumption of temporary equilibrium is derived from the existence of a variable cost function $G = G(w, Y, N, A)$. Define the long-run implicit cost function as

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

The total differentiation of (2) with respect to time t, dividing throughout by C, using the modified version of Shephard's lemma ($\frac{\partial G}{\partial w_i} = X_i$ and $-\frac{\partial G}{\partial N} = z$), and rearranging terms, yields

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

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

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

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 multifactor productivity framework—constant return to scales, perfect competition and no quasi-fixed factor of production—multifactor productivity growth is defined as $\frac{M\dot{F}P}{MFP} = \frac{\dot{Y}^P}{Y^P} - \sum_i \frac{w_i X_i}{\tilde{C}} \frac{\dot{X}_i}{X_i} - \frac{uN}{\tilde{C}} \frac{\dot{N}}{N}$, 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 multifactor productivity growth gives the following new measurement framework of multifactor productivity growth:

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

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 multifactor productivity growth and breakdown this measure into the factors contributing to multifactor productivity growth rates. These factors include i) a shift in the cost function due to technical change $\left(-\frac{\dot{A}}{A}\right)$, 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 iv) 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 a temporary equilibrium, especially that associated with the business cycle, can bias measured productivity growth away from its long-run path (see Morrison 1999, Chapter 2). The productivity residual is adjusted in a consistent manner to accommodate forms of a 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 multifactor productivity 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

1. The Data and Sample Selection

The primary source of data for this study is the administrative data collected by the Office of the Superintendent of Financial Institutions (OSFI) on operations that insurance companies (life insurance and non-life insurance) booked in

Canada. The particular data set employed contains information on premiums earned and claims incurred by product line, investment income, and general expenses which include information on labour compensation, capital depreciation, and intermediate inputs. The latter include tangible intermediate inputs but also payments made by insurance companies in the form of professional fees, management fees, and counselling fees for various services obtained in the market.

The econometric approach employed in this paper requires a panel of firms with data continuously available over a sample period sufficiently long to capture the dynamic of entry/exit. I chose the thirteen-year period 1985-2000, the longest period for which all the data I needed were available for the purpose of this study. My sample initially consisted of all federally registered insurance companies operating in Canada for which the data were available over the sample period, a total of 2221 life insurers and 3135 non-life insurers. I encountered data problems with some of the insurance firms, including negative outputs, and, in a few cases, negative net worth. Further investigation revealed that most of these problems were attributable to insurers that were approaching insolvency, exiting major lines of business, or winding down their operations. In addition, as it is often the case in studies of technological structures at the firm level, some firms operate under a monoproduct technology whereas others use a multiproduct technology. While most studies on the insurance cost structures select the Box-Cox technique which permits outputs to be zero for some firms in some lines, this approach, however, provides results that are not invariant to units of measurement (see Dagenais and Dufour 1992). This might explain why the evidence on the returns to scale in the insurance industry conducted on a country-specific basis has been rather mixed.

My sample consists of multiple line firms rather than specialized firms: i.e., non-life insurance companies providing automobile insurance, property insurance, and liability insurance and life insurance companies providing life insurance and annuities. Multiple line firms account for the vast majority of industry nominal output and are more likely than specialized firms to access significant economies of scope. While deleting specialized firms from consideration reduces the likelihood that specialization of economies of scope will be mistakenly identified as (in)efficiency, it may also create a selectivity bias which leads to inconsistent parameter estimates. As discussed below, I used the appropriate estimation technique to correct for this bias. Eliminating these firms reduced the final sample to 1524 observations of non-life insurance companies and 1092 observations of life insurance companies. 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 summary statistics of the data 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 80% of the market; however, this proportion is not constant over time across product lines, with the important changes occurring in the non-life 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 excluded monoproduct companies changed from one period to the next and that there was relatively high turnover rate among multiproduct firms motivates taking selectivity bias into account in the estimation of short-run cost function parameters.

[Insert Table I here]

2. The Variables

Input prices*:* Outputs are produced using three variable inputs: labour, capital and intermediate inputs. The price of labour equals salaries plus benefits divided by number of employees. The price of capital is defined as the ratio of occupancy and fixed-asset expense to net insurer's premises. Net insurers' premises include the depreciatiated book balances for premises, equipment, and other physical assets, including capitalized leases. The price of intermediate inputs is determined as the sum of management fees, professional fees divided by the value of financial assets. There is a miscellaneous component of intermediate inputs that consists of several diverse items, such as books, periodical, postage and telephone for example. The price of miscellaneous items is difficult to ascertain from OSFI data. For empirical purposes, the input's price of the miscellaneous items is assumed to be constant across all firms.

Output: The proper definition of output is a problem that continues to plague all insurance costs studies. Most of the measurement of output relating to insurance services overlooks the investment activity of insurance. It is not uncommon for underwriting gain and, accordingly, value added to be negative. The insurance business profitability is preserved by net receipts of investment income. In this study, nominal output, net of reinsurance, is measured as premiums *less* claims *plus* investment income companies (see Harchaoui 2000 for more details).

The rational behind this treatment is the following: insurance companies usually perform two activities. First, they are engaged in a 'pure insurance' activity, i.e. they sell insurance policies for a premium P on which they pay a claim with expected value C. If the premium and claim payments are coincident in time, the companies' gross output in an expected value sense is $V = P - C$. The second activity performed by insurance companies is financial intermediation activity; it arises from the fact that premiums are paid at time 0 in advance of claims which are paid at time 1. Essentially, the problem of negative underwriting gain results from the error of comparing dollars of one period (P is valued at time 0) with dollars of another period (C is valued at time 1). The expression $P(1+r)$, where r is the interest rate, is premium revenue properly expressed in dollars of the same period of time as claims are paid. Clearly, the financial intermediation activity of insurance companies is made explicit via an imputation equal to $P \cdot r$, the investment income, to be added to the underwriting income.

Unlike premiums and claims, investment income is not available by product line. Therefore, it 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 for the determination of their corresponding implicit prices necessary to obtain constant prices. The same information for non-life 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.

Variable Costs: 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. Insurance claims by policyholders are losses and are not included in the cost function as they are firm liabilities. Commissions paid to independent agents/brokers are not accounted for in the variable cost function as they represent a payment for the service provided by the network (a quasi fixed input).

Size of the network: Testing the hypothesis that network externalities matter requires variables that capture the network size. The majority of insurance policies are written through agents and brokers. Agents are independent, usually representing several insurers. They issue policies, collect premiums and retain exclusive rights to solicit renewals from customers. There are also exclusive agents who represent only one insurer or group of related insurers. The principal distinguishing feature of the independent agency system is that the agents usually own the renewal rights on the insurance they sell. Non-life insurance agents usually are paid the first-year commission each time the policy is renewed. Because the operational pattern of life insurers does not include renewal rights to insurance sold, the independent agency system normally is not used in the life insurance business. Life insurers generally use the exclusive agency system. Life insurance agents are usually paid a high commission the first year, a much smaller one for several years and then a token commission for the policy's remaining life.

The network variable represents a adequate proxy to the number of locations from which the services produced by the insurance can be sold. Of the 60 non-life insurance firms and 28 life insurance firms used on average in the estimation of the econometric model, about 80 percent of them operate through an independent agency system and the remaining exclusive agents. The network has features similar to capital stock: it provides a flow of services and has an asset dimension. The rental cost of the network is estimated by the ratio of commissions to the size of the network, and the size/stock is approximated by the number of insurance agents and brokers doing business with the insurance company.

IV. Econometric Implementation

1. Accounting for Selectivity Bias

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 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

$$G = \begin{cases} G(w,Y,N,A) + \omega & \text{iff } Y = (Y_1, Y_2, \ldots, Y_m) \\ 0 & \text{otherwise.} \end{cases} \quad (7)$$

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 (7), 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 use the procedure developed by Heckman (1979) that involves an OLS estimation of an expanded short-run cost function $G(\cdot)$. The conditional expectation of a multiproduct firms' short-run cost function can be written as

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

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 suggests 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 suggests 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.

2. Accounting for Idiosyncrasies

Since I am dealing with a pooled sample of firms, the issue of heterogeneity is an important one. Unobserved firm heterogeneity that persists over time may introduce serial correlation and, although OLS parameter estimates remain consistent, 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 non-life insurance firms can be expected to operate under different technologies, ii) within any business, firm-specific heterogeneity exists because of differences in ownership and control and iii) entry and exit of firms.

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 for organization firm: $D_W = 1$ if the firm is a mutual company; otherwise, $D_W = 0$. The dummy variables $DE(t)$ and $DX(t)$ capture the turnover that occurs in the 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, $DX(t)=0$.

The panel data set of multiproduct firms used is incomplete as a result of turnover in terms of entry/exit. The use of a balanced panel raises the possibility of a bias in the estimates since new firms (those that opened during 1985-2000) and unsuccessful firms (those that closed during the same period) are systematically excluded from this panel. 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 measured erroneously due to changes in the sample of firms over time.

3. The Econometric Specification

Given the technology $G(w,Y,N,A)$, a translog variable cost function is parameterized 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), and an index of industry-wide technical change (A). This cost function has an important difference from many specification in that the standard time trend has been replaced with an unobserved general index of technical change A (Baltagi and Griffin 1988). The parameterization of the short-run cost function of a multiproduct firm $f\left(1,2,..,F\right)$ is

$$\begin{aligned}\ell nG_{ft} &= \alpha_o + \lambda_W D_W + A(t) + \alpha_h h + \sum_i \alpha_i \ell nw_i + \sum_s \gamma_s \ell nY_s + \phi_N(\ell nN) \\ &+ \tfrac{1}{2}\sum\sum \alpha_{ij}(\ell nw_i)\left(\ell nw_j\right)\sum_i\sum_s \alpha_{is}(\ell nw_i)\left(\ell nY_s\right) + \sum_i \alpha_{iA}\ell nw_i A(t) \\ &+ \sum_i \alpha_{iN}(\ell nw_i)(\ell nN) + \tfrac{1}{2}\sum_s\sum_{s'} \gamma_{s,s'}\left(\ell nY_s\,\ell nY_{s'}\right) + \tfrac{1}{2}\phi_{NN}(\ell nN)^2 \\ &+ \sum_s \gamma_{As}A(t)(\ell nY_s) + \phi_{AN}A(t)(\ell nN) + \sum_s \beta_{sN}(\ell ny_s)(\ell nN) + \xi_{ft}.\end{aligned} \tag{8}$$

The estimation of (8) would be a simple matter if only $A(t)$ was observable. However, using time-specific dummy variables D_t $(t=1,2,...,T)$ and a pooled data set, I estimated (8) together with two of the corresponding three share equations (see Baltagi and Griffin 1988; Dionne and Gagné 1992),

$$
\begin{aligned}
\ell n G_{ft} &= \lambda_W D_W + \sum_t \eta_t D_t + \alpha_h h + \sum_s \sum_t \gamma_{s,t} (\ell n Y_s) D_t + \sum_t \phi_{Nt} (\ell n N) D_t + \sum_i \sum_t \alpha^*{}_{it} (\ell n w_i) D_t \\
&+ \tfrac{1}{2} \sum_i \sum_j \alpha_{ij} (\ell n w_i)(\ell n w_j) + \sum_i \sum_s \alpha_{i,s} (\ell n w_i)(\ell n Y_s) + \sum_i \alpha_{iY} (\ell n w_i)(\ell n N) \\
&+ \tfrac{1}{2} \sum_s \sum_{s'} \gamma_{ss'} (\ell n Y_s)(\ell n Y_{s'}) + \tfrac{1}{2} \phi_{NN} (\ell n N)^2 + \sum_s \beta_{sN} (\ell n Y_s)(\ell n N) + \xi_{kt},
\end{aligned}
\quad (9)
$$

and

$$
S_i = \sum_t \alpha^*{}_{it} D_t + \sum_j \alpha_{ij} (\ell n w_j) + \sum_s \alpha_{is} (\ell n Y_s) + \alpha_{iN} (\ell n N) + \mu_{kt}. \quad (10)
$$

Equations (9) and (10) are identical to the parameters in (8) if and only if

$$
\begin{aligned}
\eta_t &= \alpha_o + A(t) + \pi(t) DE(t) + \psi(t) DX(t) \\
\alpha^*{}_{it} &= \alpha_i + \alpha_{iA} [A(t) + \pi(t) DE(t) + \psi(t) DX(t)] \\
\gamma_{st} &= \gamma_s + \gamma_{As} [A(t) + \pi(t) DE(t) + \psi(t) DX(t)] \\
\phi_{Nt} &= \phi_N + \phi_{AN} [A(t) + \pi(t) DE(t) + \psi(t) DX(t)].
\end{aligned}
\quad (11)
$$

Estimates of $A(t)$, the industry-wide measure of pure technical change, can be derived by imposing the restrictions in (11) on the system of equations (9) and (10). 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 $A(t)$.

V. Empirical Results

1. Overall Results

With a data set consisting of 1524 observations on non-life insurance companies and 1092 observations on life insurance companies for the period 1985-2000, 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 parameters for life and non-life are estimated separately for the general model (equations (9) and (10). The results are displayed in Tables II. The standard tests for a well-behaved cost function were supported.[3] As noted earlier, the exclusion of monoproduct firms from the sample raises the issue of sample

[3] The results of symmetry and concavity were not rejected. Homogeneity, however, was rejected for non-life insurance only; nonetheless, it was imposed.

selection bias, which occurs if the excluded firms differ systematically in their cost characteristics from the included ones. Heterogeneity between mutual and non-mutual firms, captured by the dummy variable λ_W , is also significant. Sample selection bias is 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 f captures the otherwise missing information related to the excluded non-multiproduct firms. Sample selection bias related to the entry/exit of multiproduct firms was investigated by testing the hypothesis $\pi(t) = \psi(t) = 0$ for $t = 2,3,...,T-1$. The results of the likelihood ratio test 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.[4]

[Insert Tables II here]

Firm level estimates of multifactor productivity growth are developed and weighted as a share of industry output to produce industry-level estimates of multifactor productivity along with a breakdown into technical change, scale economies, price-cost margin, and temporary equilibrium effect. In Table IIIa, life insurance companies' multifactor productivity growth was found to increase at an average annual rate of 1.7 percent for the period 1985-2000. From 1985 to 1988, multifactor productivity grew at an average annual rate of 1.0 percent. For the 1988-1995 period, a substantial decline in comparison to the previous period (a modest 0.5 percent) was detected in the multifactor productivity growth, reflecting the effect of the business cycle. An important recovery in the multifactor productivity growth rate was noticeable during the subsequent recovery period (2.3 percent). It is of interest to see that there are identifiable differences of multifactor productivity between life and non-life insurance companies. Inspection of entries in Table IIIb indicates that, on average, life insurance companies enjoyed a productivity growth more than twice their non-life insurance counterparts. With an average annual growth of multifactor productivity of 0.7

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[4] 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.

percent, non-life insurance companies displayed relatively anemic productivity growth. The pattern of the non-life insurance business is identical to that of life insurance companies; that is, the multifactor productivity growth grew faster during the period of economic growth, experienced a major decline during the recession, and strongly recovered from 1995 to 2000, a period marked by major investments in information technology (see Harchaoui and Tarkhani 2005)).

[Insert Tables III here]

2. The Decomposition of Multifactor Productivity Growth

The results of the estimated multifactor productivity growth breakdown indicate that, for the 1985-2000 period, scale economies account for a substantial portion (65 percent for life insurance and 55 percent for non-life insurance), followed by technical change with a contribution of about 25%, and price-cost margin (14.4 percent for life insurance and 18.4 percent for non-life insurance); the remainder is the effect of temporary equilibrium, which seems to have a modest contribution on multifactor productivity growth. It is the joint effect of the network externalities and the magnitude of services that explains the substantial share of economies of scale (more on that below).[5] The share of technological change is explained by the effect of information technology and its spillover effect in this industry.[6] The insurance industry has undergone two waves of technological changes. The first occurred in the early 1970s when large frame computers came into extensive use throughout the industry. The computers sharply decreased processing costs, reduced work force needs and centralized clerical function at

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[5] Returns to scales (RTS) adjusted for the benefits generated by the existence of a network are measured as $RTS = \frac{\left(1-\varepsilon_{G,N}\right)}{\sum_s \varepsilon_{G,Y_s}}$, 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 . See Caves *et al.* (1984).

[6] Estimates of these spillovers in the case of the US financial sector by Bresnahan (1986) are found to be substantial.

head offices. Agents' offices also could plug into companies' central data processing system. The second change occurred in the early 1990s as low-cost minicomputers and microcomputers made their way into the offices of both small and large firms, particularly in labour-intensive activities such as data storage and retrieval, billings and claim processing.

The fact that life insurance companies' scale-augmenting technical change contribution to productivity 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 Registered Retirement Savings Plans 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 influence the growth of this business.

The effect of market structure represents the third major component of multifactor productivity growth after economies of scale and technical change. The contribution of market structures to multifactor productivity growth is higher for non-life insurance than 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 of price-cost margin to multifactor productivity growth. Problems of information asymmetry in favour of firms against policyholders, who lack knowledge of the price and quality characteristics of the product, may explain why prices depart from marginal cost. Price discrimination across consumers by firms is possible as each individual contract sale is a negotiated bilateral exchange between a consumer and the insurer, who knows how consumers respond to price changes through information revealed by potential buyers. The asymmetric information which favours the firm enables her to sell essentially similar products at different prices to different consumers (see Mathewson 1983).

Although the network size has experienced a positive, albeit small, year-over-year growth rate, the effect of temporary equilibrium on multifactor productivity growth has experienced three distinct trends during the 1985-2000 period. The effect of temporary equilibrium was positive during the subperiod 1985-1988, and 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 multifactor productivity 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 1985-1988, there was a strong incentive for network investment, which ultimately led the industry to use the network to full capacity.[7] This trend was slightly reversed during the 1988-1992 subperiod as the economy entered a recession, during which there was an apparent excess capacity. 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 recovery.

3. Productivity Growth by Size of Firms

To provide insight on how company size may affect multifactor productivity, estimates of multifactor productivity are given by quartile. Inspection of entries in Tables III indicate that, for the period 1985-1997, the productivity growth rate declines with the firm size and this result holds for both life and non-life insurance businesses. Also, there is a great deal of differences in the contribution of the different components of multifactor productivity between very large firms

[7] 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.

and large firms (respectively, first and second quartile) and small firms and very small firms (respectively, third and fourth quartile). With a contribution that is higher than 60 percent, non-constant returns to scale represent the major component of very large life and non-life insurers' multifactor productivity growth rate; technical progress and price-cost margin are the second major contributors with roughly 20 percent each. Although small in percentage, the contribution of temporary equilibrium, indicates that the network of very large firms (particularly life insurers) operated under capacity during the period under investigation. In contrast, for very small firms, the contribution of technical progress to multifactor productivity growth during the 1985-2000 period was almost as important as the returns to scale.

During the period of economic growth (1985-1988), the higher multifactor productivity growth displayed by very large firms, in comparison with their smaller counterparts, is mainly determined by non-constant returns to scale (roughly 60 percent), followed far behing by technical progress and price-cost margin (with roughly 20 percent each); the multifactor productivity growth rate of small firms is mainly determined by non-returns to scale (almost 50 percent) and technical progress (roughly 1/3). While large firms outperformed their small counterpart during the period of economic growth, they have in general seen their multifactor productivity growth declining substantially during the recession period (1988-1995). The recession period appears to be like the turning point in the multifactor productivity growth of both very small and large firms as the former started to outperform the latter. The highest multifactor productivity growth rate experienced by small firms during the post 1985-1995 period in comparison to larger firms was mainly the result of a dramatic and persistent increase in the contribution of technical progress. While the contribution of technical progress in the multifactor productivity growth of small firms was increasing at a faster pace than non-constant economies of scale during the periods 1988-1995 and 1995-2000, it remained roughly constant for large firms. This suggests that, unlike small-medium size firms, large ones may have reached a technological frontier in which the sources of earlier rapid productivity growth start to be exhausted. Remarkably, this result holds form both life and non-life insurance companies.

VI. Conclusion

The primary focus of this paper is on modeling and estimation of multifactor productivity growth in the Canadian insurance business. Changes in multifactor productivity 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 measurement of the multifactor productivity growth is based on an incomplete panel data set at the firm level for the period 1985-1997; it is applied to life and non-life insurance companies operating in Canada as an illustration. 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. The correction for selectivity bias is made at two levels: 1) the otherwise missing information on monoproduct firms excluded from the sample is accounted for in the estimation of the cost structure and 2) entry/exit is captured in the parameters of the cost structure.

We are now in a better position to understand the trends in multifactor productivity growth in this business. The findings indicate that although life insurance companies out perform their non-life counterparts in terms of multifactor productivity growth, the bulk of this growth for both types of firms is a result of scale economies and technical change. There is evidence of that firms, particularly in the non-life insurance industry, have substantial price setting abilities as suggested by a non-negligible contribution or price-cost margin to multifactor productivity growth. There are problems of information asymmetry that favour insurance firms against consumers who lack knowledge of the price and quality characteristics of the product. Price segmentation across policyholders by firms is possible as each individual contract sale is a negotiated bilateral exchange between a consumer and the insurance company.

There is strong evidence that the long-run hypothesis underlying the non-parametric multifactor productivity framework has been violated. The results suggest that, in general, the level of various economic performance indicators declines with the firm size. 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.

References

Bresnahan, T.F. (1986); 'Measuring the Spillovers from Tachnical Advance: Mainframe Computers in Financial Services,' *American Economic Review* 76: 742-55.

Baltagi B.H. and J. M. Griffin (1988); 'A General Index of Technical Change,' *Journal of Political Economy* 96: 20-41.

Burbidge, J.B. and Davies, J.B. (1994); 'Government Incentives and Household Saving in Canada,' in Poterba J. (Ed.): **Public Policies and Household Saving**, pp. 19-56, Chicago University Press for the NBER, Chicago.

Caves, D.W., Christensen, L.R. and Trethway M.W. (1984); 'Economies of Density Versus Economies of Scale: Why Trunk and Local Service Airline Costs Differ?' *Rand Journal of Economics* 15: 471-89.

Dagenais M.G. and J.-M. Dufour (1992); 'Invariance, Nonlinear Models, and Asymptotic Tests,' *Econometrica* 89: 1601-15.

Daly, M.J., Rao, P.S. and Geehan, R.R. (1985); 'Productivity, Scale Economies and Technical Progress in the Canadian Life Insurance Industry,' *International Journal of Industrial Organizations* 3: 345-61.

Dionne, G. and R. Gagné (1996); 'Progrés technique et croissance de la productivité: estimations sur un panel incomplet de firmes ayant des qualités de production différentes,' *Économie et Prévision*, No. 126, (Numéro spécial sur l'analyse des comportements économiques à partir des données de panel).

Globerman, S. (1984); **The Adoption of Computer Technology by Insurance Companies**, Ottawa, Supply and Services Canada.

Hall, R.E. and J.B. Taylor (1991); '**Macroeconomics**, Third Edition, Norton, New Jersey.

Harchaoui, T.M. (2000); 'Dealing with the Insurance Business in the Economic Accounts,' in Dionne G. (Ed.): **Handbook of Insurance**, Kluwer Academic Publishers, Boston.

Harchaoui, T.M., and F. Tarkhani. 2004b. "Whatever Happened to Canada-U.S. Economic Growth and Productivity Performance in the Information Age?" *OECD Economic Studies,* 40: 127-165.

Heckman (1979), J. 'Sample Selection Bias as a Specification Error,' *Econometrica* 47: 153-161.

Mathewson, G.F. (1983); Information, search and Price Variability of Individual Life Insurance Contracts,' Journal of Industrial Economics, 12: 29-41.

Morrison, C.J. (1999); **Cost Structure and Measurement of Economic Performance: Productivity, Utilization, Cost Economies, and Related Performance Indicators**. Kluwer Academic Publishers, Boston.

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

	1985			2000		
Non-Life Insurance	**Property**	**Auto**	**Liability**	**Property**	**Auto**	**Liability**
All firms (1)	1,819	2,219	469	2,721	4,000	783
Multiproduct firms (2)	1,624	2,038	421	2,242	3,399	719
(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	6,912		10,596
Multiproduct firms (2)	2,338		3,511	5,813		9,827
(2) ÷ (1) in %	85.9		89.2	84.1		92.7
	Life Insurance			Non-Life Insurance		
Turnover Rate (in %)[a] (1985-2000)	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	Variable	Estimate	$t-$statistic
α_o	3.0512	2.113	γ_{AY_L}	0.0124	3.167	$\psi(88)$	-0.0449	2.018
α_L	0.2214	3.710	γ_{AY_A}	0.1131	5.234	$\psi(89)$	-0.0711	2.012
α_M	0.1296	2.811	ϕ_{AN}	0.0923	2.451	$\psi(90)$	-0.1298	1.978
γ_{Y_L}	0.1081	3.126	$\beta_{Y_L N}$	0.2192	5.221	$\psi(91)$	-0.0823	3.129
γ_{Y_A}	0.2342	5.234	$\beta_{Y_A N}$	0.3381	3.819	$\psi(92)$	-0.4412	3.129
ϕ_N	0.2813	2.313	λ_W	-0.0812	2.871	$\psi(93)$	-0.4012	2.455
α_{LL}	0.1511	2.411	α_h	1.3101	4.023	$\psi(94)$	-0.3866	2.523
α_{MM}	0.0512	1.934	$\pi(86)$	0.0912	1.611	$A(86)$	-0.1011	2.011
α_{LM}	-0.0113	2.915	$\pi(87)$	0.0312	1.809	$A(87)$	-0.0978	2.801
α_{LY_L}	0.0912	2.981	$\pi(88)$	0.0102	1.611	$A(88)$	-0.0489	3.912
α_{LY_A}	0.1123	2.673	$\pi(89)$	0.0512	1.987	$A(89)$	-0.0712	2.012
α_{MY_L}	-0.0221	1.875	$\pi(90)$	0.1012	2.876	$A(90)$	-0.1123	3.123
α_{MY_A}	-0.0102	1.773	$\pi(91)$	0.0399	2.011	$A(90)$	-0.1123	3.123
α_{LA}	0.0051	2.121	$\pi(92)$	0.0093	1.311	$A(91)$	-0.1245	3.891
α_{MA}	-0.0155	2.127	$\pi(93)$	0.0023	1.098	$A(92)$	-0.0778	5.897
α_{LN}	0.0114	2.174	$\pi(94)$	0.0102	1.134	$A(93)$	-0.0983	3.089
α_{MN}	0.0128	2.861	$\pi(95)$	0.0017	1.431	$A(94)$	-0.1377	4.912
$\gamma_{Y_L Y_L}$	0.2312	3.481	$\pi(96)$	0.0149	1.913	$A(95)$	-0.1012	3.091
$\gamma_{Y_A Y_A}$	0.3581	4.534	$\pi(97)$	0.0204	2.087	$A(96)$	-0.0779	2.116
$\gamma_{Y_L Y_A}$	0.0871	2.012	$\psi(86)$	-0.0198	1.013	$A(97)$	-0.0871	1.874
ϕ_{NN}	-0.2253	2.413	$\psi(87)$	-0.0145	1.997			

Equation	**Std. Error**	R^2
Cost	0.06156	0.92
Labour Share	0.02267	0.84
Intermediate Input Share	0.01912	0.85
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	Variable	Estimate	$t-$statistic
α_o	0.0102	3.467	$\gamma_{Y_AY_L}$	0.1366	4.129	$\psi(88)$	-0.0314	1.781
α_L	0.1169	1.982	ϕ_{NN}	-0.1652	4.336	$\psi(89)$	-0.0591	3.227
α_M	0.0914	1.758	γ_{AY_P}	0.0234	2.110	$\psi(90)$	-0.0798	4.126
γ_{Y_P}	0.0774	4.125	γ_{AY_A}	0.0761	1.997	$\psi(91)$	-0.0516	2.474
γ_{Y_A}	0.1281	3.339	γ_{AY_L}	0.1183	4.125	$\psi(92)$	-0.1293	2.987
γ_{Y_L}	0.2341	4.181	ϕ_{AN}	0.07112	3.667	$\psi(93)$	-0.1147	3.074
ϕ_N	0.3112	4.167	β_{Y_PN}	0.0543	1.714	$\psi(94)$	-0.0071	2.851
α_{LL}	0.0912	1.912	β_{Y_AN}	0.0123	1.667	$\psi(92)$	-0.1293	2.987
α_{MM}	0.0417	2.012	β_{Y_LN}	0.1711	3.123	$\psi(93)$	-0.1147	3.074
α_{LM}	-0.0221	1.698	λ_W	0.1226	4.121	$\psi(94)$	-0.0071	2.851
α_{LY_P}	0.0152	1.711	α_h	2.017	3.148	$\psi(92)$	-0.0914	1.824
α_{LY_A}	0.0781	1.991	$\pi(86)$	0.0107	1.981	$\psi(93)$	-0.0131	2.714
α_{LY_L}	0.1023	3.012	$\pi(87)$	0.0212	2.016	$\psi(94)$	-0.0541	3.337
α_{MY_P}	-0.0981	1.814	$\pi(88)$	0.0314	3.117	$A(86)$	-0.0367	3.157
α_{MY_A}	-0.0114	2.115	$\pi(89)$	0.0174	3.339	$A(87)$	-0.0407	1.889
α_{MY_L}	-0.1098	3.119	$\pi(90)$	0.0471	4.125	$A(88)$	-0.0566	2.471
α_{LA}	0.0088	3.874	$\pi(91)$	0.0701	1.974	$A(89)$	-0.0889	9.771
α_{MA}	-0.0978	1.689	$\pi(92)$	0.0093	2.447	$A(90)$	-0.1202	2.971
α_{LN}	0.0447	1.978	$\pi(93)$	0.0023	0.557	$A(91)$	-0.1011	2.339
α_{MN}	0.0011	1.551	$\pi(94)$	0.0097	2.007	$A(92)$	-0.0519	2.997
$\gamma_{Y_PY_P}$	0.1102	1.997	$\pi(95)$	0.0136	2.014	$A(93)$	-0.0711	2.339
$\gamma_{Y_AY_A}$	0.1477	2.411	$\pi(96)$	0.0104	1.0179	$A(94)$	-0.1209	5.971
$\gamma_{Y_LY_L}$	0.1827	2.866	$\pi(97)$	0.0124	3.107	$A(95)$	-0.1488	2.789
$\gamma_{Y_PY_A}$	0.0275	1.886	$\psi(86)$	-0.0077	1.147	$A(96)$	-0.0254	2.147
$\gamma_{Y_PY_L}$	0.0981	2.113	$\psi(87)$	-0.0142	2.227	$A(97)$	-0.0125	3.149

Equation	Std. Error	R^2
Cost	0.08914	0.87
Labour Share	0.03478	0.84
Intermediate Input Share	0.04417	0.85

Log of Likelihood	2,143

Table IIIa. Multifactor Productivity Growth and Its Sources by Quartile:
Life Insurance Business

Time Period	Multifactor Productivity in %	Percentage Contribution to Multifactor Productivity of			
		Non-Constant Returns to Scale	Technical Progress	Temporary Equilibrium	Price-Cost Margin
Q1	2.1	62.3	17.6	1.2	18.9
Q2	1.0	61.7	18.4	4.1	15.8
Q3	0.2	56.7	31.1	8.9	3.3
Q4	1.0	44.1	37.6	16.2	2.1
1985-1988	**3.3**	**59.8**	**21.1**	**4.1**	**15.0**
Q1	0.9	69.7	19.6	-8.8	19.5
Q2	0.3	73.2	20.1	-5.9	12.6
Q3	-0.3	64	35.1	-1.2	2.1
Q4	-0.6	60.5	40.1	-2.4	1.8
1988-1995	**0.5**	**68.9**	**23.3**	**-6.8**	**14.6**
Q1	1.1	70.9	22.6	-10.6	17.1
Q2	2.9	67.2	22.3	-4.1	14.6
Q3	2.5	59.1	44.5	-5.3	1.7
Q4	2.1	43.9	48.9	5	2.2
1995-2000	**2.3**	**66.3**	**27.4**	**-7.2**	**13.6**
Q1	2.0	67.6	19.9	-6.1	18.5
Q2	1.3	67.4	20.3	-2.0	14.3
Q3	1.4	59.9	36.9	0.8	2.4
Q4	1.1	49.5	42.2	6.3	2.0
Average	**1.7**	**65.0**	**23.9**	**-3.3**	**14.4**

Note: 1Q = first quartile (very large firms, nominal output higher than 550 millions); 2Q = second quartile (large firms, nominal output between 250 millions and 550 millions); 3Q = third quartile (small firms, nominal output between 75 millions and 250 millions) and 4Q = fourth quartile (very small firms, nominal output lower than 75 millions).

Table IIIb. Multifactor Productivity Growth and Its Sources by Quartile: Non-Life Insurance Business

Time Period	Multifactor Productivity in %	Percentage Contribution to Multifactor Productivity of			
		Non-Constant Returns to Scale	Technical Progress	Temporary Equilibrium	Price-Cost Margin
Q1	1.3	58.6	17.1	1.7	22.6
Q2	0.6	52.6	22.4	4.2	20.8
Q3	0.5	50.1	27.6	7.4	14.9
Q4	0.1	48.9	31.3	6	13.8
1985-1988	**0.5**	**54.67**	**21.9**	**3.7**	**19.8**
Q1	0.5	61.3	22.3	-5.1	21.5
Q2	0.1	58.2	25.1	-2.9	19.6
Q3	-0.5	51.3	36.7	-3.6	15.6
Q4	-0.8	52.1	40.4	-3.3	10.8
1988-1995	**0.1**	**57.8**	**27.7**	**-4.2**	**18.6**
Q1	1.4	57.8	25.6	-2.6	19.2
Q2	0.9	55.3	27.9	-1.1	17.9
Q3	0.8	40.4	49.1	-2.6	13.1
Q4	0.4	38.76	51.2	-0.06	10.1
1995-2000	**1.0**	**51.8**	**33.4**	**-1.9**	**16.7**
Q1	1.0	59.2	21.7	-2.0	21.1
Q2	0.6	55.4	25.1	0.1	19.4
Q3	0.2	47.3	37.8	0.4	14.5
Q4	-0.1	46.6	41.0	0.9	11.6
Average	**0.7**	**54.8**	**27.7**	**-0.8**	**18.4**