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JEFA
ISSN 2148-6697

Journal of Economics, Finance and Accounting YEAR 2023 VOLUME 10 ISSUE 3

THE IMPORTANCE OF EFFICIENCY FOR LIFE INSURER PROFIT REGARDING CANADIAN LIFE INSURERS

DOI: 10.17261/Pressacademia.2023.1811
JEFA- V.10-ISS.3-2023(1)-p.121-136

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Date Received: June9, 2023 **Date Accepted:** September 5, 2023

To cite this document
Wise, W., (2023). The importance of efficiency for life insurer profit regarding Canadian life insurers. Journal of Economics, Finance and Accounting (JEFA), 10(3), 121-136.
Permanent link to this document: http://doi.org/10.17261/Pressacademia.2023.1811

ABSTRACT

Purpose- This study examines 1) how the efficiency of life insurers influences their profits, 2) the influence of exogenous variables such as debt ratio on profits and 3) the critical phenomenon of how feasible it is for a life company to improve its profits via efficiency improvements versus changing other characteristics of its business.
Methodology- This study uses stochastic frontier analysis along with data from Canadian life insurers to calculate the required efficiency values along with the above effects and possibilitie
Findings- The results are that it is much easier for life insurers to increase profit via efficiency improvements versus improving other business aspects that it can control such as debt ratio or percent of new business written.
Conclusion- The results point to the key conclusion that to increase profit, or regain the profit lost due to inefficiency, for the most part and conceivably totally the best, easiest and quite possibly only way for life insurance companies to influence their profit is through improving their efficiency, especially in the vital long-term

Keywords: Life ınsurance, efficiency, profit, stochastic frontier analysis, exogenous variables
JEL Codes: G22, H21, G28

1. INTRODUCTION

An effective and productive insurance sector is crucially important to and contributes to a nation's economic growth (Das et al., 2003; USAID, 2005). Consequently life insurance is a very important segment of the economy of most countries. Hence it is paramount to determine accurately how well life insurance companies (LICs) perform and how viable they are for the benefit of other industries and indeed national economies.Only fifteen of the more than three hundred and eighty studies concerning LIC efficiency observed truly examine how efficiency affects profits. Fourteen of these do not explore aspects of life insurers improving their profits. Therefore this paper goes beyond what has been previously accomplished and investigates the essential concept of the feasibility of a LIC improving its profits via efficiency versus changing other characteristics such as debt ratio. The conclusion reached is that, for the most part and conceivably totally, the best, easiest and possibly only process for LICs to influence their profit is through improving efficiency.

This paper continues with Section 2 briefly describing the Canadian life insurance industry. Section 3 provides a review of the relevant literature. Section 4 gives a portrayal of the method applied to calculate 1) efficiency and 2) the profit versus efficiency and exogenous variables. Section 5 depicts the data utilized and Section 6 gives the evaluations regarding how to change profit. Section 7 concludes.

2. A BRIEF DESCRIPTION OF THE CANADIAN LIFE INSURANCE INDUSTRY

The Canadian life and health insurance industry has more than one hundred and fifty active companies providing life and health insurance and annuities (Canadian Life and Health Insurance Association (CLHIA), 2022). It is approximately the world's eleventh largest by premiums (Swiss Reinsurance Company (SRC), 2022) with two Canadian life and health companies ranking, by asset size, in the top twenty-two of the world's largest insurance companies of any kind (A. M. Best Company, 2022) and three in the top thirty-three by market capitalization (Infinite Market Cap, 2023). Additionally it has approximately the world's seventh (twelfth) largest per capita volume of life insurance premiums when taking into account countries of any reasonable size, namely with a population of more than six (five) million (SRC 2022). The products are issued to greater than twenty-nine million Canadians along with seventy million people in more than twenty countries and territories outside of Canada (CLHIA, 2022). They include individual and group life insurance, disability insurance, individual and group annuities, retirement savings plans, individual and group health insurance, long-term care, critical illness and travel insurance. Twenty-two million Canadians have life insurance, twenty-seven million have supplementary health insurance, twelve million have disability insurance, twenty million have accident and other health coverage and over eight million Canadians have their retirement savings managed by Canadian life and health insurers (CLHIA, 2022). The industry has manufactured substantial premiums in Canada including a total of $138 billion in 2021 and in 2021 the industry paid out over $113 billion in benefits (CLHIA, 2022).

3. LITERATURE REVIEW

Only fifteen articles truly examine how efficiency affects LIC profits and only Wise (2018) undertakes such an analysis for Canada. Of the fifteen, Greene and Segal (2004), Karim and Jhantasana (2005), Liu (2007), Alhassan and Addison (2013), Al-Amri et al. (2014), Alhassan et al. (2015), Wise (2018), Eling and Jia (2019), Camino-Mogro and Bermudez-Barrezueta (2019) and Tuffour et al. (2021) show that the inefficiency of life companies can affect their (financial) outcome and ultimately their survivorship. The others, Zhong (2009), Biener et al. (2014), Jiang and Chen (2015), Parida and Acharya (2017) and Jaloudi and Bakir (2019) decide that (pure) technical efficiency has no effect on profit. However notwithstanding the foregoing the fifteen contain deficient aspects.

Considering the flaws; Greene and Segal (2004) and Karim and Jhantasana (2005) use stochastic frontier analysis (SFA) but use a second stage to evaluate how efficiency is influenced by exogenous variables. Such an approach is a weakness, the main reason being that in the first stage of the two-stage approach the inefficiency (u_i) variables are assumed to be independent and identically distributed whereas in the second stage they are not. The latter is as the u_i variables are assumed to have a functional relationship with the exogenous variables (Kumbhakar and Lovell, 2000; Zanghieri, 2009). Another chief reason that the one-stage approach is better is none of the variables are completely exogenous, i.e. they are correlated with elements of the functions applied in the first stage, which can lead to biased estimates in the second stage (Berger and Mester, 1997; Wang and Schmidt, 2002).Table 1 has a list of the problems of the papers and explanations:

Table 1: Problems in the Papers Investigating Efficiency Affecting Profits and Explanations as to Why They are Problematic

Paper	Problem	Explanation
Greene & Segal (2004)	Second stage regression with SFA	See text above
	Face Value as output	See text below
	Investments as output	See note (1) below
Karim & Jhantasana (2005)	Second stage regression with SFA	See text above
	Assets as output	See note (1) below
	Claims as output	See text below
	Reserves as output	See text below
Liu (2007)	Uses DEA	See text below
	Small number of inputs	See text below
	Common input prices	See note (2) below
Zhong (2009)	Uses DEA	See text below
	Not enough DMUs	See note (3) below
Alhassan & Addison (2013)	Uses DEA	See text below
	After tax profit as output	See text below
	Claims to premiums ratio as regressor vs ROA	See text below
Al-Amri, Cummins & Weiss (2014)	Uses DEA	See text below
	Uses second stage regression	See note (4) below
	Assess LI & GI as one	See note (5) below
	Input price of equity is common by country	See note (2) below
	Input price of reserves is common by country	See note (2) below
Biener, Eling & Wirfs (2014)	Uses DEA	See text below
	Uses second stage regression	See note (4) below
	Common input prices	See note (2) below
	Claims as output	See text below
	Reserves as output	See text below
	Investments as output	See note (1) below
Alhassan, Addison & Asamoah (2015)	Uses DEA	See text below
	After tax profit as output	See text below
	Claims to premiums ratio as regressor vs ROA	See text below
Jiang & Chen (2015)	Uses DEA	See text below

Parida & Acharya (2017)	Uses DEA	See text below
	Not enough DMUs	See note (3) below
	Claims as output	See text below
Camino-Mogro & Bermudez-Barrezueta (2019)	Uses DEA	See text below
	Appears to assess LI & GI as one	See note (5) below
	After tax profit as output	See text below
Eling & Jia (2019)	Appears to assess LI & GI as one	See note (5) below
	Investments as output	See note (1) below
	Before tax profit as output	Double counting as written premium is an input
Jaloudi & Bakir (2019)	Uses DEA	See text below
	Assess LI & GI as one	See note (5) below
Tuffour, Ofori-Boateng, Ohemeng & Akuaku (2021)	Investments/Reserves as output	See note (1) and text below
	Net II as OP	Double counting as Investments is an output

DEA = Data Envelopment Analysis; DMU = Decision Making Unit; GI = General Insurance

(1) LICs generate investment income (II) as an output from their assets hence to proxy output it is better to utilize the flow value (II) rather than the static value (assets) because the former gives a better idea of current ability and activity. Another difficulty with specifying assets is that they can fluctuate in value leading to an false apparent change in output.

(2) A shortcoming because insurers pay different prices for inputs such as wages, materials and capital.

(3) Zhong (2009) does not use enough decision making units (DMUs) (three) versus three inputs and one output. Parida and Acharya (2017) does not use enough DMUs (thirteen) versus four inputs and two outputs (Cooper et al., 2001; Dyson et al., 2001).

(4) The results from the second-stage regression designed to analyze the determinants of efficiency (after calculating efficiency values using DEA) are problematic because the required assumptions are not met (Golden and Yang, 2019).

(5) Treating life insurance and general insurance as one is a problem as the two industries are inherently distinct, for example a) general insurance (GI) claims are repeatable whereas with LI this is mostly not true, b) a substantial part of LI business is annuities which involves payment without the occurrence of a contingent event while this type of payment is much smaller for GI, c) LI business tends to be long-term whereas GI business tends to be short term and d) the regulations, capital requirements, etcetera of the two are (vastly) different.

Premiums appears to be a better proxy for output than either policy count or face value (FV). The superiority of premiums is demonstrated by starting with the fact that there are different premiums 1) per FV for different products and 2) as different policies have different sums insured per policy for the same product. By using three cases it is illustrated how premiums are a better output proxy than either FV or policy count.

The first case involves a comparison within the same company at the same time. As a policy generating $100 in premium gives rise to more profit it is more output than a policy generating $50 in premium. Therefore the $100 policy is more desirable and the company will not look at the two policies as the same.

The second case regards the same firm at different times where the situation might not be totally straightforward. For instance a policy yielding $50 in premium in the past may lead to more profit for the firm than a policy yielding $70 in premium now, perhaps due to expense or mortality differences. Consequently the former is greater output. However the same problem exists when employing either FV or policy count as a proxy, e.g. less FV issued previously might be perceived as more output for the same reasons. Therefore in this case premiums is as least as good a proxy for output as is either FV or policy count. For the third case, a comparison regarding diverse companies, the explanation for the second case applies. The outcome of taking the three cases into account, premiums seems to be a better proxy for output than either FV or policy count.

Reserves are not a good output proxy chiefly because they 1) represent the future not the present, 2) exhibit method and pattern differences between products, 3) have method and assumption differences between companies, 4) can be altered by company method and assumption changes and 5) can be varied by ad hoc changes. In addition reserves are not a good proxy for intermediation output. Similarly claims are not a good output proxy as 1) they are not a good measure of funds pooled and redistributed (i.e. for losses) by insurers, 2) most "real services" performed by LICs are not correlated with claim volumes, 3) claims represent past activity much more than present activity, 4) claims lead to losses of future profits and 5) they potentially increase giving the false appearance of more productivity.

Data envelopment analysis (DEA) is inappropriate for LIC efficiency research primarily because of the reasons that it 1) assumes no random error (Berger and& Mester, 1997; Cummins and Weiss, 2000), 2) assumes available inputs are similar across all DMUs (Dyson et al., 2001), 3) is designed for DMUs that do not have the usual economic goals such as profit maximization or cost minimization (Charnes et al., 1978; Sun & Zhong, 2011), 4) suffers due to exogenous constraints greatly influencing the results (Berger and Humphrey, 1991; De Luca Cardillo and Fortuna, 2000), and 5) DMUs can have very high efficiency scores simply because few others have analogous inputs, outputs or related features (Bauer et al., 1998).

LIC inputs can include items such as salaries, office costs, commission and associated costs, underwriting, marketing, systems costs, human resources, management fees, administration of investments, client service, premium collection costs, claims processing, general overhead, development costs and a plethora of others (Carr, 2004). So adopting a narrow set of input proxies versus this list results in a lack of precision decreasing outcome validity. Wise (2017) has more details, examples and explanations regarding reserves, claims, DEA and inputs.

Specifically for Alhassan and Addison (2013), Alhassan et al. (2015) and Camino-Mogro and Bermudez-Barrezueta (2019) the output proxy of net profit after tax 1) includes premiums and expenses (which the authors exploit as an input proxy) therefore results in double counting and 2) assumes that companies can control the tax they pay which generally is not true. Moreover for their measurement of how efficiency affects ROA in both Alhassan and Addison (2013) and Alhassan et al. (2015) one of the regressors is defined as the ratio of claims to premiums which 1) involves values defined as output proxies and 2) appears to be part of ROA by definition.

Another facet of LIC efficiency articles is that only five have dealt exclusively with Canada and few others have regarded Canada at all. The five have problems; 1) Kellner and Mathewson (1983) only defines a sort of pseudo-efficiency and has a sole output of the number of policies/lives, 2) Paradi (2002) only draws on data from 1998, has some common input prices (note (2) above) and includes reserves in its outputs (text above), 3) Bernier and Sedzro (2003) specifies common input prices (note (2) above) and has reserves as its output (text above), 4) Yang (2006) only exploits data from 1998 and does not incorporate prices for its inputs or outputs (so cannot calculate allocative efficiency) and 5) Wu et al. (2007) does not use any prices for its inputs or outputs (so cannot calculate allocative efficiency). Five other items are cross-country including Canada; 1) Donni and Fecher (1997) which examines fifteen OECD countries applies DEA (text above) and has the number of employees as its only input (text above) , 2) Eling and Luhnen (2010) with thirty-six countries and territories assesses life insurance and general insurance as one (note (5) above), has some common input prices (note (2) above) and reserves as its output (text above), 3) Gaganis et al. (2013) utilizing fifty-two countries and territories appraises life insurance and general insurance as one (note (5) above), 4) Biener and Eling (2012) with twenty-one countries computes life insurance and general insurance as one (note (5) above), has common input prices (note (2) above) and reserves as its output (text above) and 5) Eling and Jia (2019) with ninety-one countries and territories contains the problems as seen in Table 1 above.

Therefore, this paper improves on what has been implemented to date by avoiding the aforementioned problems.

4. METHOD

4.1. The Cost Function

SFA is employed to calculate efficiency. SFA computes maximum output (i.e. the "frontier") that can be obtained with a given set of inputs. The frontier can also be evaluated as the minimum indispensable input to generate a given set of outputs.

When utilizing SFA it is most common to apply the logarithmic form

$$\ln M_i = \ln f(k_i; \beta) + v_i - u_i. \tag{1}$$

with $f(k_i; \beta)$ the functional form of the efficient frontier, M_i the measured value, k_i values the independent variables and β the parameters to be estimated. Noise is represented by v_i and u_i represents inefficiency.

The basic functional form specified in this research for the efficiency frontier is the translog function:

$$\beta_0 + \sum_1^N \beta_n \, lnk_n + ½ \sum_1^N \sum_1^M \beta_{nm} \, lnk_n \, lnk_m \tag{2}$$

Following Berger and Mester (1997), the cost function evaluated applying the translog functional form[1], with the time subscript suppressed for notational ease, is

$$\ln\left(\frac{C_i}{w_{Ni} A_i} - \theta_C + .001\right) =$$

[1] *The cost function used by Berger & Mester (1997) is actually a FF functional form with a translog kernel.*

$$\alpha_0 + \sum_{n=1}^{N} \beta_n \ln\left(\frac{w_{ni}}{w_{Ni}} - \theta_n + .001\right) + \sum_{m=1}^{M} \gamma_m \ln\left(\frac{y_{mi}}{A_i} - \theta_m + .001\right) +$$
$$\frac{1}{2}\sum_{j=1}^{N}\sum_{k=1}^{N} \delta_{jk} \ln\left(\frac{w_{ji}}{w_{Ni}} - \theta_j + .001\right) \ln\left(\frac{w_{ki}}{w_{Ni}} - \theta_k + .001\right) +$$
$$\frac{1}{2}\sum_{j=1}^{M}\sum_{k=1}^{M} \epsilon_{jk} \ln\left(\frac{y_{ji}}{A_i} - \theta_j + .001\right) \ln\left(\frac{y_{ki}}{A_i} - \theta_k + .001\right) +$$
$$\frac{1}{2}\sum_{j=1}^{N}\sum_{k=1}^{M} \zeta_{jk} \ln\left(\frac{w_{ji}}{w_{Ni}} - \theta_j + .001\right) \ln\left(\frac{y_{ki}}{A_i} - \theta_k + .001\right) +$$
$$+ v_i + u_i \qquad (3)$$

for insurer *i* with C_i its cost incurred, A_i its asset value, w_i its input prices, y_i its output quantities, the ϑ values such that the lowest value to take the natural log of is .001 for each variable (set), and the α, *β, γ, δ, ε* and *ζ* parameters estimated. As insurers can control reinsurance, the cost, prices and quantities are all net of reinsurance. Analogously as insurers mostly cannot control income tax the cost, prices and quantities are all before income tax. Finally v_i represents noise and u_i represents inefficiency.

4.2. Efficiency Measurement

After the computation of the parameter estimates in the cost function the efficiency scores are assessed. Following Kumbhakar and Lovell (2000) the first step in appraising cost inefficiency is to calculate the average of the residuals u_i from Equation (3) for each insurer *i*.

$$u_i^* = \frac{1}{T_i}\{\sum_t ln\left(\frac{C_i}{w_{Ni}(A_i)} - \theta_C + .001\right) - \widehat{\alpha_0} - \sum_t \hat{\bullet}\ \ln(\xi)\ \} \qquad (4)$$

for insurer *i*, with T_i the number of its panel data observations, $\hat{\alpha}_0$ and $\hat{\bullet}$ the parameter estimates and the $\sum_t \hat{\bullet}\ \ln(\xi)$ values representing all of the summation terms in Equation (3).

Then for each insurer *i*

$$\hat{u}_i = u_i^* - \min_i\{u_i^*\} \qquad (5)$$

is evaluated and its cost efficiency is

$$CE_i = \exp\,(-\hat{u}_i). \qquad (6)$$

The cost efficiency measure derived via equation (6) assumes that the most efficient insurer has the lowest cost residual, which is the idea incorporated by Berger and Mester (1997) found in equation (7):

$$\frac{C^{min}}{C^i} = \frac{\exp\,[f(w^i y^i)]u_i^{*min}}{\exp\,[f(w^i y^i)]u_i^*} = \frac{u_i^{*min}}{u_i^*} \qquad (7)$$

with *C* being the $\ln\left(\frac{C_i}{w_{Ni}A_i} - \theta_C + .001\right)$ values of the LHS of equation (3); *f* the functional form (here the translog function); *w*, and the input prices and output quantities; and *min* referring to the most efficient company.

The inspiration underpinning equation (7) is that the cost efficiency of company *i* is compared to the most efficient company if both draw on the same sets, namely of company *i,* of input prices, outputs quantities and exogenous variables.

4.3. The Profit Functions and Efficiency Measurement

When writing the cost function (3) as

$$C_i = f(w_i, y_i, u_i, v_i) \qquad (8)$$

for the alternate and standard profit functions, respectively, the equivalents to (8) are

$$\Pi_i = f(w_i, y_i, u_i, v_i) \qquad (9)$$

and

$$\Pi_i = f(w_i, p_i, u_i, v_i) \qquad (10)$$

with Π_i the profit generated by insurer *i* and the p_i its output prices.

For profit efficiency the most efficient insurer is assumed to have the highest profit residuals so (incorporating the profit function equivalent of equation (5))

$$\hat{u}_i = \max_i\{u_i^*\} - u_i^* \tag{11}$$

is calculated; hence the profit efficiency of insurer *i* is

$$PE_i = \exp(-\hat{u}_i). \tag{12}$$

The alternate profit efficiency equivalent of equation (7) is

$$\frac{\Pi^i}{\Pi^{max}} = \frac{\exp\,[f(w^i y^i)]u_i^*}{\exp\,[f(w^i y^i)]u_i^{*max}} = \frac{u_i^*}{u_i^{*max}} \tag{13}$$

with Π being the $\ln\left(\frac{\Pi_i}{w_{Ni}A_i} - \theta_\Pi + .001\right)$ values corresponding to the $\ln\left(\frac{C_i}{w_{Ni}A_i} - \theta_C + .001\right)$ values of the LHS of equation (3); *f* the functional form; *w* and *y* the input prices and output quantities; and *max* referring to the most efficient company. The standard profit efficiency equivalent of equation (13) is the same except that p^i values replace the y^i values.

4.4. Profit versus Efficiency

Having determined the cost and profit efficiency scores for each LIC; this paper investigates the crucial concept of how efficiency impacts their profitability. Two profit values, measured as excess returns over Canadian Government bond yields, are utilized. These are

1) ROE which is defined for each year as profit/equity less the average ten-year Canadian Government bond yields and
2) ROA which is defined for each year as profit/assets less the average ten-year Canadian Government bond yields.

For ease of expression the standard terms of ROE and ROA are specified to refer to the profit values. Moreover the impact on Average ROE and Average ROA is analyzed as these 1) account for lags, e.g. giving new business a chance to be profitable, 2) eliminates aberrations and 3) “resist[s] the common - but unrealistic - assumption that profits are maximized in each and every year” (Humphrey and Pulley, 1997:74).

To establish the influence efficiency has on profit model (14) is drawn on. It includes the impact factors on profit of 1) the year of operation, 2) (natural log of) asset size, 3) the debt ratio (DR), 4) the percent of new business written (PNB) by the company, 5) the Minimum Continuing Capital and Surplus Requirement (MCCSR) ratio and 6) whether a company is domestic.

For ROE

$$ROE_i = \beta_0 + \beta_{effy}CE_i + \sum_{x=2000}^{2015}\beta_x D_{xi} + \beta_{lnasize}lnA_i + \beta_{drat}DebtRatio_i +$$

$$\beta_{pnew}PercNew_i + \beta_{mrat}MCCSRRatio_i + \beta_{dom}D_{dom\,i} \tag{14}$$

is applied for insurer *i* with $DebtRatio_i$ its DR, $PercNew_i$ its PNB, $MCCSRRatio_i$ its MCCSR ratio, D_{xi} dummy variables for its years of operation, $D_{dom\,i}$ a dummy variable for its domesticity, the *β* parameters estimated and time subscripts suppressed for notational ease. Equivalent regressions are used for ROA and profit efficiency.

For Average ROE and efficiency

$$\overline{ROE_i} = \beta_0 + \beta_{effy}CE_i + \beta_x\bar{D}_i + \beta_{lnasize}ln\bar{A}_i + \beta_{drat}\overline{DebtRatio}_i +$$

$$\beta_{pnew}\overline{PercNew}_i + \beta_{mrat}\overline{MCCSRRatio}_i + \beta_{dom}D_{dom\,i} \tag{15}$$

is incorporated for insurer *i* with $\overline{ROE_i}$ its Average ROE, $\bar{A}_i$ its average asset size, $\overline{DebtRatio}_i$ its average DR, $\overline{PercNew}_i$ its average PNB, $\overline{MCCSRRatio}_i$ its average MCCSR ratio, $D_{dom\,i}$ a dummy variable for its domesticity, the *β* parameters estimated and time subscripts suppressed for notational ease. Equivalent regressions are used for ROA and profit efficiency.

4.5. Profit versus Exogenous Variables

In addition to appraising how efficiency impacts LIC profitability this study determines the possibility of their improving profit via the exogenous variables. Evaluating how easy it is for a LIC to change its profit using each exogenous variable involves comparisons. The first is between 1) the change necessary in the exogenous variable to change profit and 2) the average current situation, concerning the exogenous variable, of the companies involved. For example, as depicted in Table 7 for

PNB/Average ROE, the current average is 34.76. The change necessary to increase Average ROE by one hundred basis points (bps) is then quantified, using the parameter estimate of 0.3032, as 3.30 which is 9.49% of the current 34.76.

The second comparison is between 1) the change necessary in each exogenous variable to change profit and 2) the situation of each company, with respect to the exogenous variable, in the individual company/years specified in this article. For example, concerning PNB/ROE, the largest company/year observation is 699.5. Therefore the change necessary to increase ROE by one hundred bps (776.4) is more than 110.9% of the current amount for all individual company/year observations.

Whether it is possible, difficult or impossible for an insurer to increase its profit utilizing each exogenous variable (except domesticity) is then determined employing specific criteria. These outcomes are then compared to how easily a LIC can improve its profit via efficiency to conclude whether to increase profit LICs should try to improve efficiency or should try to change the value of an exogenous variable.

5. DATA

The cost and profit functions along with the profit versus efficiency parameters are estimated incorporating unbalanced panel data and generalized least squares. Nineteen years of return data submitted to the Canadian life insurance regulator, the Office of the Superintendent of Financial Institutions (OSFI) data, 2000-2018, are drawn on. The OSFI-linked website http://data.beyond2020.com/osfi/osfi_en.htm has the data. The data used are restricted to LICs licensed by OSFI to issue life insurance and do so. Companies that are only allowed to service policies or only issue reinsurance are excluded. LICs included total forty-three domestic companies and thirty-seven foreign owned companies. On average about 11.5 years are used for each company. The measurements were implemented applying Stata as distributed by StataCorp LP.

For input proxies as detailed a list as feasible is incorporated. Hence six are utilized; claim payments; surrender values & other payments; dividends & experience rating refunds (ERRs); expenses of acquiring new business; expenses of operations with respect to existing business; and assets & interest on policyholder amounts on deposit (IPHA). Four output proxies are utilized; insurance premiums, annuity premiums, accident and sickness (A&S) premiums and investment income.

For each of the cost, alternate profit and standard profit efficiency investigations a few company/year observations were excluded from the original total of 922. Furthermore a number of the input and output prices and output quantities were adjusted to correct for unduly large fluctuations and other anomalies. Contact the author for the Alternate and Standard Profit summary statistics.

Table 2: Summary Statistics -Cost Efficiency

Company Characteristic	All Companies		Domestic Companies	Foreign Companies
Companies (N=)	80		43	37
Company/Years (N=)	916		495	421
Variable (Type)	**Minimum**	**Maximum**	**Average**	**Standard Deviation**
Primary variables ($000)				
Cost *(C)*	-1675535	12613542	360632	1069642
Asset Size *(A)*	2466	69739664	2365629	6972719
Input Prices				
Claims (w_1)	-6.465	3355.000	40.497	122.606
SVs & OPs (w_2)	-0.619	305.000	2.183	12.337
Dividends & ERRs (w_3)	-1.094	73.023	0.228	2.473
Acquiring New Business (w_4)	-0.741	19.646	0.394	1.070
Operations wrt Existing Business (w_5)	-2.742	25.968	0.471	1.600
Assets & IPHA (w_6)	-0.001	0.260	0.004	0.011
Outputs ($000)				
LI Premiums (y_1)	-1156206	5094239	114461	378129
Annuity Premiums (y_2)	-62012	2143309	67531	231432
A&S Premiums (y_3)	-598066	2368589	80289	234189
Investment Income (y_4)	-397334	3907407	111805	366217

Profit vs Efficiency variables[2]				
Debt Ratio *(DebtRatio)*	0.000	0.798	0.023	0.078
Percent of New Business Written *(PercNew)*	-135.895	6.995	0.159	4.522
MCCSR Ratio (*MCCSRRatio*)	0.957	144.974	3.194	6.397
ROE (Excess Return)	-14.828	23.752	0.085	0.967
ROA (Excess Return)	-0.640	1.964	0.021	0.129

Notes: Some data from potential companies and company/years not included are used in some capacity.
w_1 = value of claim payments divided by their number
w_2 = value of SVs & OPs divided by their number
w_3 = value of dividends & ERRs divided by their number
w_4 = expenses on a per premium basis
w_5 = total expenses attributable to existing business per non-new business policy/certificate
w_6 = value of investment expenses & IPHA divided by the value of the company's assets
DR = Debt/(Debt + Equity)
PNB = (net First Year and Single Premiums)/(net First Year and Single Premiums plus net Renewal Premiums)
MCCSRRatio for domestic (foreign-owned) companies = total capital ((net) assets available/total capital ((net) assets) required

6. Results and Discussion

Four cases are analyzed for each efficiency measurement namely ROE, ROA, Average ROE and Average ROA. The importance of efficiency on LIC profit becomes evident upon exploring the possibility of changing profit via the exogenous variables. The conclusion reached is that to increase profit, or regain the profit lost due to inefficiency, for the most part and plausibly entirely, efficiency may be the best, easiest and possibly only way to influence LIC profit.

6.1. Parameter Estimates and Changing Profit

This section exhibits the effect of cost and profit efficiency and the other variables on LIC profit and the degree to which each independent variable (that a life insurer can control) needs to be altered to attain a one hundred bp improvement in the profit measures. Whether it is possible, difficult or impossible for an insurer to increase profit using each exogenous variable (except domesticity) is also determined. These outcomes are then compared to how easily a LIC can improve profit through efficiency to conclude whether they should 1) use efficiency to increase profit or 2) change one of the exogenous variables.

The parameter estimates obtained from models (14) and (15) for efficiency, the (natural log of) asset size, DR, PNB, MCCSR ratio and domesticity are mostly consistent in sign and statistical significance as Table 3 shows:

Table 3: Parameter Estimates and Statistical Significance Values

Model/Parameter	Cost Efficiency	Alternate Profit Efficiency	Standard Profit Efficiency
Efficiency			
ROE	0.2115**	0.8470***	1.0426***
Average ROE	1.9443***	0.8929***	0.8485***
ROA	0.1099***	0.4417***	0.7739***
Average ROA	0.3018***	0.5529***	0.8430***
Ln(Asset Size)			
ROE	0.0079**	0.0094***	0.0102***
Average ROE	0.1182***	0.0949***	0.1116***
ROA	-0.0052***	-0.0061***	-0.0067***
Average ROA	0.0070***	0.0028*	0.0022*
Debt Ratio			
ROE	-0.2699***	-0.2198**	-0.2129**
Average ROE	-1.6419***	-1.1803***	-1.0638***
ROA	-0.0214	-0.167	-0.0226
Average ROA	-0.2137***	-0.2144***	-0.2123***
%New Business			
ROE	0.0013	0.0013	0.0012
Average ROE	0.3032***	0.1757***	0.2588***

[2] Both DR and PNB are expressed as values equal to 100 times the relevant percentage (as opposed to percentages) throughout this paper.

ROA	0.0002	0.0002	0.0001
Average ROA	0.0045	-0.0308***	-0.0149***
MCCSR Ratio			
ROE	0.0009	0.00003	-0.0003
Average ROE	0.0926***	0.0706***	0.0751***
ROA	-0.0001	-0.0002	-0.0002
Average ROA	0.0173***	0.0097***	0.0081***
Domesticity			
ROE	0.0521***	0.0557***	0.0303***
Average ROE	-0.2256***	-0.0994***	-0.1795***
ROA	0.0121***	0.0218***	0.0084***
Average ROA	-0.0245***	0.0110**	0.0088**

*** = significant to a 1% level
** = significant to a 5% level
* = significant to a 10% level

The consistency of the sign and significance of the parameter estimates found in Table 3 tends to demonstrate that the models (14) and (15) are valid. The Average ROE and Average ROA assessments represent the company/year observations spread over eighty companies and thus an average of about eleven and one-half and up to nineteen observations per company. This means that the Average ROE and Average ROA appraisals probe longer-term traits of profit versus the exogenous variables than do those of ROE and ROA. Hence the parameter estimates and statistical significance values for Average ROE and Average ROA may be better indicators of reality because life insurance is a long-term proposition. Consequently as the efficiency parameter estimates in Table 3 are mostly higher for the average profit computations; efficiency is even more vital to LICs in the more critical long-term versus the short-term.

The conclusion from the preceding combined with Tables 4 through 9 is that for the most part and potentially entirely the best, easiest and possibly only way for a LIC to influence profit is by changing its efficiency. The only cases where it seems possible to change profit via a characteristic other than efficiency have one or more caveats attached.

6.1.1. Changing Profits Using Efficiency

To illustrate, using the parameter estimates first consider how easy it is for a LIC to change profit using cost efficiency. Table 4 displays the relevant values regarding efficiency and life insurer profit:

Table 4: Parameter Estimates and Changes Necessary to Increase Profit Measures by 100 Basis Points – Cost Efficiency

Profit Measure	**Value**		**Notes**
ROE	Parameter Estimate	0.2115**	
	Change Necessary	4.73%	4 of 80 companies have inefficiency < 4.73%
	Average Inefficiency	14.07%	
Average ROE	Parameter Estimate	1.9443***	
	Change Necessary	0.52%	1 of 80 companies has inefficiency < 0.52%
	Average Inefficiency	13.97%	
ROA	Parameter Estimate	0.1099***	
	Change Necessary	9.10%	9 of 80 companies have inefficiency < 9.10%
Average ROA	Parameter Estimate	0.3018***	
	Change Necessary	3.32%	4 of 80 companies have inefficiency < 3.32%

*** = significant to a 1% level
** = significant to a 5% level

As per equations (7) and (13) of Section 4.2 this efficiency study calculates the efficiency of each LIC assuming it does not change its input prices, outputs, output prices and exogenous variables. Accordingly as shown in Table 4, decreasing inefficiency by the amount necessary to increase a profit measure by one hundred bps is clearly possible. For the worst case, ROA, the average inefficiency is 14.07% and the change necessary to increase ROA by one hundred bps is 9.10%. As only nine of the eighty companies have an inefficiency of less than 9.10%, it seems possible to increase ROA using efficiency. For each profit efficiency measure either one or two of the eighty companies have an inefficiency less than the change necessary to increase profit by 100 bps. Hence the analogous for alternate and standard profit efficiency are even more indicative of the ability of LICs to change profit through efficiency.

Contrasted to easily being able to change profit via efficiency, the results below exhibit that LICs cannot easily change profit via one of the other business aspects that it can control.

6.1.2. Changing Profit Using Asset Size

The first such aspect analyzed concerns how easily a LIC can change profit using asset size. Table 5 shows the relevant values for cost efficiency with respect to asset size and LIC profit:

Table 5: Parameter Estimates and Changes Necessary to Increase Profit Measures by 100 Basis Points
Natural Log of Asset Size - Cost Efficiency

Profit Measure	Value	
ROE	Parameter Estimate	0.0079**
	Change Necessary	1.273
	Necessary Asset Size Change	≥356%
Average ROE	Parameter Estimate	0.1182***
	Change Necessary	0.0846
	Necessary Asset Size Change	≥108%
ROA	Parameter Estimate	-0.0052***
	Change Necessary	-1.905
	Necessary Asset Size Change	≥85%[a]
Average ROA	Parameter Estimate	0.0070***
	Change Necessary	1.432
	Necessary Asset Size Change	≥418%

*a: Decrease in asset size, *** = significant to a 1% level, ** = significant to a 5% level*

As to changing profit Table 5 demonstrates that, when taking into account the parameter estimates, to change one of the profit measures by one hundred bps necessitates an insurer changing its natural log of asset size by a positive quantity of at least 1.088 or a negative quantity of at most -1.905. This equates to an insurer increasing its asset size by at least 108% or decreasing it by at least 85%, both of which are clearly impossible.[3] For each profit efficiency measure an insurer must either increase its asset size by at least 109% or decrease it by at least 77%, so the analogous for alternate and standard profit efficiency are as telling of the inability of LICs to change profit through changing its asset size.

6.1.3. Changing Profit Using Debt Ratio (DR)

DR is a special case in that only 123 company/year observations are greater than zero leading to the investigation being further carried out confined only to those. Table 6 illustrates the relevant values regarding DR and LIC profit:

Table 6: Parameter Estimates and Necessary Debt Ratios (DRs) to Increase Profit Measures by 100 Basis Points
Debt Ratio All Companies and Only Companies with Positive Debt Ratio - Cost Efficiency

Profit Measure	Value		% Required Change is of Current Average DR Cost (Alternate / Standard)
ROE	Parameter Estimate	-0.2699***	
	Necessary DR: All Companies	-1.39	
	Necessary DR: DR >0 Only	13.53	21.5% (26.4% / 27.2%)
	Current Average (All)	2.31	
	Current Average (DR>0)	17.24	
Average ROE	Parameter Estimate	-1.6419***	
	Necessary DR: All Companies	2.89	17.4% (24.2% / 26.9%)
	Necessary DR: DR >0 Only	12.11	4.8% (6.7% / 7.4%)
	Current Average (All)	3.50	
	Current Average (DR>0)	12.72	
ROA	Parameter Estimate	-0.0214	
	Necessary DR: All Companies	-44.42	
	Necessary DR: DR >0 Only	-29.50	
Average	Parameter Estimate	-0.2317***	

[3] Contact the author for values and details corresponding to the profit measures not referred to in the text for each of Asset Size, DR, PNB and MCCSR ratio for both profit reductions due to average inefficiency and specific company/years and companies.

ROA	Necessary DR: All Companies	-1.18	
	Necessary DR: DR >0 Only	8.04	36.8% (36.7% / 37.0%)

*** = significant to a 1% level

Note: For positive necessary DRs the numbers in the right-most column are the percent, that the required change is, of the current average to achieve said necessary DR. For example, for ROE/CE/>0 the current average is 17.24 so achieving the necessary DR of 13.53 requires a change of 3.71 which is 21.5% of the current 17.24. The values in parentheses are the equivalent percentages for APE and SPE.

For changing profit, Table 6 exhibits that, when considering the parameter estimates and both 1) all companies and 2) only companies with positive DR, to change one of the profit measures by one hundred bps necessitates an insurer changing its DR either to 1) a negative amount which is impossible or 2) except for Average ROE/DR>0 a positive amount that is difficult or impossible for the insurer to obtain. It can be noted that for Average ROE/CE/DR>0 the required change is 4.8% of the current average DR which is not difficult, but the required change for Average ROA/CE/DR>0 is 36.8% of the current average DR which is impossible for a LIC. Tables 6 also shows that the required change for the profit efficiency measures are more than for cost efficiency.

6.1.4. Changing Profit Using Percent of New Business Written (PNB)

Table 7 shows the relevant values with respect to PNB and LIC profit. Looking at changing profit Table 7 illustrates that, when investigating the parameter estimates, to change one of the profit measures by one hundred bps necessitates an insurer changing its PNB either to 1) such a high amount as to be impossible, 2) a negative amount which is impossible or 3) except for Average ROE a positive amount that is difficult or impossible for the insurer to obtain. It can be noted that for Average ROE/CE the required change is 9.5% of the current average PNB which is not difficult, but the required change for Average ROA/CE is 634% of the current average PNB which is impossible for a LIC. Tables 7 additionally shows that, except for Average ROA, the required change for the profit efficiency measures are more than for cost efficiency. For Average ROA/APE the required change is also impossible while for SPE the necessary PNB is negative, hence impossible.

Table 7: Parameter Estimates and Necessary PNBs to Increase Profit Measures by 100 Basis Points Percent of New Business Written (PNB) - Cost Efficiency

Profit Measure	Value		% Required Change is of Current Average PNB Cost (Alternate / Standard)
ROE	Parameter Estimate	0.0013	
	Necessary PNB	792.3	4876% (5035% / 5052%)
	Current Average	15.9	
Average ROE	Parameter Estimate	0.3032***	
	Necessary PNB	38.06	9.49% (16.2% / 11.0%)
	Current Average	34.76	
ROA	Parameter Estimate	0.0002	
	Necessary PNB	6036	37814% (31645% / 95047%)
Average ROA	Parameter Estimate	0.0045	
	Necessary PNB	255.1	634% (-92.6% / N/A)

*** = significant to a 1% level

Note: For positive necessary PNBs the numbers in the right-most column are the percent, that the required change is, of the current average to achieve said necessary PNB. For example, for CE/ROE the current average is 15.92 so achieving the necessary PNB of 792.32 requires a change of 158.72 which is 4876.4% of the current 15.92. The values in parentheses are the equivalent percentages for APE and SPE.

6.1.5. Changing Profit Using MCCSR Ratio

Table 8 exhibits the relevant values for MCCSR ratio and life insurer profit. As to changing profit Table 8 displays that to change either ROE or ROA by one hundred bps necessitates an insurer changing its MCCSR either to 1) such a high amount as to be impossible or 2) a negative amount which is also impossible. For Average ROE/CE the required change is 4.67% of the current average MCCSR which is not difficult, but the required change for Average ROA/CE is 24.9% of the current average PNB which may be difficult for a LIC. Furthermore Tables 8 shows that the required change for the profit efficiency measures are more than for cost efficiency. For ROE/SPE the necessary MCCSR is negative, hence impossible.

Table 8: Parameter Estimates and Necessary MCCSR Ratios to Increase Profit Measures by 100 Basis Points - Cost Efficiency

Profit Measure	Value		% Required Change is of Current Average MCCSR Cost (Alternate / Standard)
ROE	Parameter Estimate	0.0009	
	Necessary MCCSR	14.947	368% (10505% / N/A)
	Current Average	3.194	
Average ROE	Parameter Estimate	0.0926***	
	Necessary MCCSR	2.422	4.67% (6.13% / 5.76%)
	Current Average	2.314	
ROA	Parameter Estimate	-0.0001	
	Necessary MCCSR	-105.9777	
Average ROA	Parameter Estimate	0.0173***	
	Necessary MCCSR	2.891	24.9% (44.5% / 49.2%)

*** = significant to a 1% level

Note: For positive necessary MCCSRs the numbers in the right-most column are the percent, that the required change is, of the current average to achieve said necessary MCCSR. For example, for ROE the current average is 3.194 so achieving the necessary MCCSR of 14.947 requires a change of 11.754 which is 368.0% of the current 3.194. The values in parentheses are the equivalent percentages for APE and SPE.

6.1.6. Additional Considerations

Average cost inefficiency has reduced insurer ROE by 29.0%; to regain this by changing a company's 1) DR necessitates decreasing it by 107.4; 2) PNB necessitates increasing it by 225.0 or 3) MCCSR necessitates decreasing it by 340.695, each of which is clearly impossible. The results are much the same for Average ROE, ROA and Average ROA and are generally more extreme for the profit efficiency calculations.

The above calculations scrutinize averages only. The same conclusions apply for the specific company/year observations. For example, for cost efficiency to change ROE by one hundred bps the company has to sell more than 10.0% of current debt for all except ten of 916 company/year observations; has to decrease the amount of PNB by greater than 111.0% of the current value for all 916 or has to increase its MCCSR ratio by more than 30% of the current amount for all but three of the 916. So these are either difficult or impossible for virtually all company/years. The results are much the same for Average ROE, ROA and Average ROA and for the profit efficiency calculations. Tables 9 and 10 depict the feasibility of LICs changing profit as to specific company/year observations.

As life insurance is a long-term proposition it is more realistic to consider the long-term than the short-term. In the short-term cases average cost inefficiency has reduced insurer ROE by 29.0% and insurer ROA by 33.3% of their potential. For the long-term cases average inefficiency has reduced insurer Average ROE by 73.7% and insurer Average ROA by 48.4% of their potential. Thus the long-term effect is greater than the short-term effect. For APE the trend is the same. Even though for SPE the trend is the opposite the two results are (very) close.

For the company/year observations an average of 28.2 (32.4)% of potential short-term ROE (ROA) is lost due to cost inefficiency for the applicable observations. For the long-term cases the average loss in potential profit is 71.3 (46.2)% for Average ROE (ROA). For APE the short-term values are 68.6 (67.1)% while the long-term numbers are 71.7 (68.4)%. As above for SPE the trend is the opposite but again the two results are close.

Furthermore for the short-term (long-term) cases, 22.6% and 22.4% (94.1% and 76.9%) of the individual company/year observations (companies) with a negative profit would have a positive profit if cost inefficiency were removed. For both APE and SPE the trend is the same. Hence overall for almost all cases in the discussion the long-term effect is greater than the short-term effect.

6.2. Feasibility of Increasing Profit

The results of Tables 3 through 8 are used to determine the feasibility of a LIC realizing a one hundred bp improvement in the profit measures by altering each independent variable that a life insurer can control, in (14) and (15). Table 9 summarizes:

Table 9: Feasibility of Increasing Profit by 100 Basis Points Via the Independent Variables Cost, Alternate Profit and Standard Profit Efficiency

Variable & Profit Measure	Cost	Alternate Profit	Standard Profit
Efficiency			
ROE	Possible	Possible	Possible
Average ROE	Possible	Possible	Possible

ROA	Possible	Possible	Possible
Average ROA	Possible	Possible	Possible
Ln(Asset Size)			
ROE	Impossible	Impossible	Impossible
Average ROE	Impossible	Impossible	Impossible
ROA	Impossible	Impossible	Impossible
Average ROA	Impossible	Impossible	Impossible
Debt Ratio (DR)			
ROE	Impossible	Impossible	Impossible
Average ROE	Difficult/Impossible	Impossible	Impossible
ROA	Impossible	Impossible	Impossible
Average ROA	Impossible	Impossible	Impossible
DR >0 Only			
ROE	Impossible	Impossible	Impossible
Average ROE	Possible	Possible	Possible
ROA	Impossible	Impossible	Impossible
Average ROA	Impossible	Impossible	Impossible
DR Co/Years			
ROE	Possible/Difficult/Impossible	Possible/Difficult/Impossible	Possible/Difficult/Impossible
Average ROE	Possible/Difficult/Impossible	Possible/Difficult/Impossible	Possible/Difficult/Impossible
ROA	Impossible	Impossible	Impossible
Average ROA	Impossible	Impossible	Impossible
% New Business			
ROE	Impossible	Impossible	Impossible
Average ROE	Possible	Difficult	Difficult
ROA	Impossible	Impossible	Impossible
Average ROA	Impossible	Impossible	Impossible
PNB Co/Years			
ROE	Impossible	Impossible	Impossible
Average ROE	Possible/Difficult/Impossible	Possible/Difficult/Impossible	Possible/Difficult/Impossible
ROA	Impossible	Impossible	Impossible
Average ROA	Impossible	Impossible	Impossible
MCCSR Ratio			
ROE	Impossible	Impossible	Impossible
Average ROE	Possible	Possible	Possible
ROA	Impossible	Impossible	Impossible
Average ROA	Impossible	Impossible	Impossible
MCCSR Co/Yrs			
ROE	Difficult/Impossible	Impossible	Impossible
Average ROE	Possible	Possible/Difficult	Possible/Difficult
ROA	Impossible	Impossible	Impossible
Average ROA	Difficult/Impossible	Difficult/Impossible	Difficult/Impossible

Note: Co/years refers to analyzing individual company/year observations as opposed to averages. For example for CE/DR/ROA, for all nine hundred and sixteen specific company/year observations the necessary change is more than 75% of the current amount so is deemed as impossible.

The main conclusion to draw from Table 9 is that in almost all cases it is either difficult or impossible for a LIC to improve its profit by changing a business characteristic that it can control (other than efficiency). There are some cases where it seems possible to change profit via such a characteristic however they all have one or more caveats attached as described in Table 10.

Table 10: Caveats Regarding Possibility of Changing Profit Measures

Characteristic	Profit Measure Seemingly Possible to Change	Caveats
DR>0 only	Average ROE	Impossible for both ROE and Average ROA
DR company/years	ROE	Possible for only 3 of >900 observations for all efficiency calculations
DR company/years	Average ROE	1) Possible for only 12/11/11 of 80 companies for CE/APE/SPE efficiency calculations. 2) Impossible for Average ROA for all companies
PNB	Average ROE	Possible for CE only where it is impossible for both ROE and Average ROA
PNB company/years	Average ROE	1) Possible for only 31/16/25 of 80 companies for CE/APE/SPE efficiency calculations 2) Impossible for both ROE and Average ROA for all companies
MCCSR	Average ROE	Impossible for both ROE and Average ROA
MCCSR company/years	Average ROE for most companies	Difficult or impossible for both ROE and Average ROA for all companies

Considering the results of Table 9 along with the associated caveats the conclusion is for the most part and conceivably totally the best, easiest and possibly only way for LICs to influence profit is through improving efficiency.

7. CONCLUSIONS

The key conclusion reached from the outcomes in Tables 5 through 9 is that to increase profit, or regain the profit lost due to inefficiency, for the most part and believably completely a LIC must change a business aspect that it can control (other than efficiency) enough to be difficult or finds it impossible. On the other hand Tables 4 and 9 illustrate that to increase profit using efficiency is definitely possible. This means that, especially in the vital long-term, for the most part and feasibly wholly the best, easiest and possibly only way for life insurance companies to influence their profit is through improving their efficiency.

Other important conclusions that can be taken include that the sign and significance of the parameter estimates of Table 3 being consistent tends to demonstrate that the models (14) and (15) are valid. Secondly, as the efficiency parameter estimates in Tables 3 and 4 are mostly higher for the average profit measures, it seems that efficiency is a critically greater determinant of LIC profit in the more realistic long-term than in the short-term. The latter indicates that a LIC should pay strict attention to efficiency as it is a central element of the life insurance business.

Life insurance is a long-term proposition so the long-term results of Section 6.1.6 are more crucial than the short-term results. In almost all features examined the influence of efficiency is greater in the long-term than in short-term. As well the greater long-term influence shows that, concerning the effect of efficiency and other variables on profit, for the most part and conceivably totally the best, easiest and possibly only way for LICs to influence profit is through improving efficiency, especially in the vital long-term.

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