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The importance of efficiency for life insurer profit: A study of Canadian life insurance companies

William WISE
bill1612018@mail.com

Abstract. *Only six studies, of more than two hundred and sixty observed concerning life insurance company (LIC) efficiency, truly examine how efficiency affects profits. Four show inefficiency greatly affects LIC (financial) outcome and survivorship. This clearly indicates that LIC efficiency is crucial to assess, significantly enhancing the ability to monitor LICs.*
The six papers, not exploring profit improvement, contain deficiencies. This paper is the first to analyze the feasibility of life insurers improving profit via efficiency versus other business characteristics. The conclusion is that the best and possibly only process for LICs to increase profit is via efficiency.

Keywords: life insurance, efficiency, profit, output/input proxies, stochastic frontier analysis.

JEL Classification: G22, H21, G28.

1. Introduction

The role of the financial sector in the economic development of any country is very significant so an effective and productive insurance sector ultimately contributes to a nation's economic growth. Consequently life insurance is a very important segment of the economy of most countries and 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 six studies, of the more than two hundred and sixty observed concerning life insurer efficiency, truly examine how efficiency affects profits. Nonetheless they contain deficiencies (see Section 3) and do not explore aspects of life insurers improving their profits. Therefore this paper goes beyond what has been accomplished in the past to analyze how feasible it is for a life insurer to improve its profits via efficiency improvements versus changing other characteristics of its business. The conclusion reached is that the best, easiest and quite possibly only process for life companies to influence their profit is through improving efficiency.

Section 1 continues with a justification of why life insurance and studying its efficiency are important, Section 2 briefly describes the Canadian life insurance industry and Section 3 provides a review of the relevant literature. Section 4 has a detailed explanation of output proxies and which are (in)appropriate. Section 4 also has a short discussion of input proxies and Section 5 has a portrayal of the method applied to calculate 1) efficiency and 2) profit versus efficiency and exogenous variables. Section 6 depicts the data used and Section 7 gives the efficiency results and evaluations regarding changing profit. Section 8 concludes.

1.1. The importance of life insurance and its efficiency

That life insurance is essential to a well-functioning economy of most developed nations is demonstrated by its investments, premium revenue and numbers employed. Wise (2018) exhibits the values that the life insurance industry in the large economies of the United States, Canada, Europe, Asia and Japan has invested. Examples from 2015 are $6.2 trillion (Tr) in the United States and $2.4Tr USD in Asia ex-Japan in 2015. Furthermore in 2016 greater than 2.6Tr USD in premium was generated by the life insurance industry worldwide (Swiss Reinsurance Company Limited, 2017). Wise (2018) also shows that large numbers are employed in the industry for example in 2015 more than 2.5 million in the United States and at least 1.3 million in Europe.

Life insurance is additionally crucial as the insurance industry is vital to the wellbeing of other industries, households and a nation's overall economy (Davidson, 2001; Ofoeda et al., 2012). Thus as the insolvency of an insurer can have a devastating effect on a country's economy,[(1)] it is imperative that life insurers be viable and profitable. Such a bankruptcy can also harm the financial services industry in general because, among other reasons, insurers have large amounts of funds under management, insurance premiums represent a substantial percentage of worldwide GDP and some insurance conglomerations include major banking and derivative activities (The Geneva Association Systemic Risk Working Group, 2010).

In addition, even though various jurisdictions have guaranty associations which help protect policyholders with respect to their vulnerabilities, the associations only account for part of the promised payment so policyholders can still be hurt badly in the event of a bankruptcy (Assuris, 2015; Life Insurance Company Guaranty Corporation of New York, 2017). A life enterprise bankruptcy can also harm the policyholders of the remaining life insurers as they have to pay part of the resultant cost (Barrese and Nelson, 1994; Yasui, 2001). Hence as well as to a nation's overall economy, life insurer viability is important to individual policyholders. Accordingly the conclusion drawn from the above is that due to 1) the large investments, revenue and employment of life insurers, 2) life insurance being central to the wellbeing of other industries, households and a nation's overall economy, 3) policyholders having have a large sensitivity to and dependency on company survival and 4) all policyholders potentially being hurt badly in the event of a bankruptcy it is critical that regulators and other stakeholders evaluate the sustainability and viability of life insurers correctly and properly.

Now, efficiency is a main determinant of a company's viability in that it represents the company's capability to create outputs (such as premiums and investment income) incorporating inputs (such as administrative and sales staff and financial capital) (Farrell, 1957; Shephard, 1970). In appraising its efficiency each business in an industry is compared to a "best practice" efficient frontier with scores between zero and one; an insight generally held to be introduced by Debreu (1951) and Farrell (1957). Thus as efficiency is a measure of the deviation between the actual and desired performance of a firm such as the maximization of outputs or profit, the minimization of costs, or other similar objectives it is evident that efficiency is essential for a company to endure. Indeed, quantifying insurance company efficiency helps improve service quality and solve their problems (Kueng, 2000). Also, one principal feature of four of the pieces that truly look at how efficiency affects life insurance profits is that they illustrate that the inefficiency of life companies can greatly affect their (financial) outcome and ultimately their survivorship.

So, given that 1) it is critical that regulators and other stakeholders evaluate the sustainability and viability of life insurance companies correctly and properly and 2) studies clearly indicate that life institution efficiency is crucial to the viability and survivorship of life companies, it is clear that it is fundamental to examine and assess life entity efficiency with doing so greatly enhancing the facility to properly monitor and inspect life insurers.

2. A Brief description of the Canadian life insurance industry

The Canadian life and health insurance industry consists of one hundred and fifty-six active companies providing life and health insurance and annuities (CLHIA, 2016). The industry is approximately the world's tenth largest by premiums with three Canadian life and health companies ranking in the top fifteen of the world's largest (CLHIA, 2016). It has approximately the world's eleventh (fifteenth) largest per capita volume of life insurance premiums when taking into account countries of any reasonable size.[(2)]

The products are issued to greater than twenty-eight million Canadians (CLHIA, 2016) and include individual and group life insurance, disability insurance, individual and group annuities, retirement savings plans, health insurance, critical illness and travel insurance. More than twenty-two million Canadians have life insurance, twenty-four million have extended health insurance, twelve million have disability insurance, twenty-one million have other health coverage and 3.2 million have individual annuity contracts (CLHIA, 2015; CLHIA, 2016). The industry has written substantial premiums in Canada including $103 billion in 2015 and in 2015 the industry paid out $84.2 billion in benefits (CLHIA, 2016).

3. Literature review

The efficiency literature until 2000 concerning financial institutions exhibits two prominent traits namely 1) few regard any connection between efficiency and company financial results and 2) few explore life insurance. Even since 2000 these characteristics have been continued in life establishment efficiency papers in that of the greater than two hundred and sixty inspected few consider insurer profits in any manner and no paper undertakes such an analysis for Canada. Additionally only six articles truly examine how efficiency affects life enterprise profits.

Of the six, Greene and Segal (2004), Karim and Jhantasana (2005), Liu (2007), and Alhassan and Addison (2013) show that the inefficiency of life concerns greatly affect their (financial) outcome and ultimately their survivorship. The others, Zhong (2009) and Jiang and Chen (2015), decide that (pure) technical efficiency has no effect on profit as the parameter estimates have no significance. However notwithstanding the foregoing the six contain deficient aspects.

With respect to only the most egregious flaws; Greene and Segal (2004) and Karim and Jhantasana (2005) quantify the efficiency scores with a two-stage approach. 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 *iid* 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 (Fenn et al., 2008; Kumbhakar and Lovell, 2000).

Other chief reasons that the one-stage approach is better are 1) no variable is completely exogenous, i.e. they are correlated with 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), and 2) the endogeneity noted earlier in the two-stage approach means that the outcomes of the second stage should be interpreted as giving information only on correlation; not causation (Hasan and Marton, 2003).

The output proxies of the readings have drawbacks. Greene and Segal (2004) incorporates face value of life insurance sold, annuity considerations, A&H premiums and investments; Karim and Jhantasana (2005) utilizes claims, policy reserves and assets whereas Alhassan and Addison (2013) uses premiums net of reinsurance and net profit after tax, the latter including reserves and claims. However the proxies of face value (Wise, 2018), claims, policy reserves, investments and assets are all problematic.

Section 4.1.1 describes the problems with using claims and reserves as output proxies. Concerning assets and investments, life insurance companies generate investment income as an output from their assets hence to proxy output it is better to utilize the flow value (investment income) rather than the static value (here assets) because the former gives a better idea of current ability and activity. One more difficulty with specifying assets is that they can fluctuate leading to an apparent change in output with no such change.

Also, in Alhassan and Addison (2013), the output proxy of net profit after tax 1) includes premiums and expenses (both input proxies) therefore results in double counting and 2) assumes that companies can control the tax they pay which, in general, is not true. For input proxies the studies probably cover the range of inputs in a broad sense although in actuality inputs have much greater complexity.

Moreover, Alhassan and Addison (2013) applies data envelopment analysis (DEA) (Wise, 2017) and in measuring ROA versus efficiency (the paper does not scrutinize ROE) one of the regressors, the ratio of claims to premiums 1) involves values defined as outputs and 2) appears to be part of ROA.

Liu (2007) has the shortcomings of 1) a limited number and scope of inputs with only two (Section 4.2), 2) common input prices (Wise, 2017) and 3) only four years of data. Common prices are a shortcoming because different insurers pay different prices for their inputs such as wages, materials and capital. Zhong (2009) utilizes DEA compounded with the hitch of not enough decision making units (three) versus inputs and outputs (three each) (Cooper et al., 2001; Dyson et al., 2001). Jiang and Chen (2015) 1) uses DEA, 2) only the three inputs (with no prices) and 3) all premiums combined as an output. In addition the piece only analyzes ROA, not ROE.

Another facet of life insurer 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 uses 1998 data, has some common input prices and reserves as an output, 3) Bernier and Sedzro (2003) has common input prices and reserves as outputs, 4) Yang (2006) only exploits data from 1998 and does not incorporate prices for its inputs or outputs and 5) Wu et al. (2007) does not use any prices for its inputs or outputs (Wise, 2017). Four other items are cross-country including Canada: Donni and Fecher (1997) applies DEA with one input; both Eling and Luhnen (2010) and Biener and Eling (2012) assess life insurance and general insurance as one,[(3)] have some common input prices and reserves as the output; and Gaganis et al. (2013) appraises life insurance and general insurance as one.

4. Output and input proxies

Weiss (1986, p. 54) comments that “to measure output volume, the services provided to insureds must be expressed in measurable and identifiable units” and efficiency scores obtained can be “misleading or meaningless” if outputs and inputs are not defined properly

(Cummins and Weiss, 2000; Jarraya and Bouri, 2013). Accordingly to utilize efficiency theory correctly to life companies in light of what they produce necessitates specifying the best output and input proxies.

4.1. Output proxies

4.1.1. Reserves and claims

There is a debate in the literature with respect to which of the two basic sets of prevalent output proxies drawn upon, 1) reserves (or their change) and claims or 2) premiums and investment income is more appropriate. Wise (2017) lists reasons given for exploiting (change in) reserves as 1) it is the best proxy for underwriting, claims handling and other "real" services being highly correlated with both the numbers of claims and policies, 2) reserves account, as a supplement to past losses, for expected future losses and 3) the change in reserves is a good proxy for intermediation.

Wise (2018) explains why reserves are not a good proxy for output. The chief reasons are 1) reserves represent the future as opposed to the present, 2) method and pattern differences between products, 3) method and assumption differences between companies, 4) method and assumption changes by companies, 5) ad hoc changes by companies, 6) the non-sensical output values resulting from fundamental numerical deficiencies when applying (change in) reserves as an output proxy, 7) a difficulty when exploiting DEA as the efficiency appraisal method as DEA assumes that outputs are isotonic, i.e. desirable, 8) that a quantity desired to be decreased should be thought of as an input and conversely one for which an increase is wanted an output (Charnes and Cooper, 1985) and 9) artificial reserve values in the United States and Canada, where for some products and/or jurisdictions the reserve at issue, and one (or one-and-a-half or two) year(s) after issue are all set to zero artificially. In addition Wise (2018) explains why reserves are not a good proxy for intermediation output.

Claims is linked with (change in) reserves as an output proxy. Wise (2017) presents reasons given for using claims as 1) they measure the amount of funds pooled and redistributed (i.e. for losses) by insurers, 2) said redistribution is the object of risk-pooling, 3) claims proxy real services as highly correlated with loss volumes, 4) claims equal current expenses and losses.

Hitches with employing claims begin by noting that because reserves is such a bad proxy, combining claims with them to proxy anything is dubious. In addition no insurer would encourage its employees to foster more or larger claims in an attempt to increase efficiency and large claims can be from bad underwriting and so the result of poor life insurer ability.

Another flaw is that there can be 1) incidences of suicide within the exclusionary period, 2) events such as death from a pre-existing condition or hazardous activity that are agreed not to be covered, 3) murder or 4) claims otherwise denied that result in no computed output even though the insurer clearly has performed its usual activities. In addition due to delays in claim payments using claims as an output proxy leads to a second level of estimation, whereas premiums does not (Diacon et al., 2002).

Additionally similar to reserves, Wise (2018) shows that claims are not a good output proxy mainly for the reasons of 1) they are not a good measure of funds pooled and redistributed (i.e. for losses) by insurers, 2) the object of risk-pooling (via insurance) to pay claims being questionable, 3) most "real services" performed by insurers not being correlated with claim volumes, 4) claims represent past activity much more than present activity of the insurer, 5) a claim leads to a loss of future profits, 6) claims potentially increasing (rapidly) giving the insurer of falsely appearing more productive, 7) the non-sensical output values from the fundamental numerical deficiencies if using claims as an output proxy, 8) a difficulty when exploiting data envelopment analysis to calculate efficiency as it assumes that outputs are desirable and 9) claims represent face value which is not as good an output proxy as is premiums.

4.1.2. Premiums and investment income

As to the debate in the literature between specifying premiums and investment income versus reserves and claims; it can be demonstrated that the former set is the best output proxies to draw on because the value added approach is used in most life insurance efficiency studies. Claims do not add to the value of a life insurer as claims end the policy and so the insurer foregoes any future profits and other benefits received plus claims result in the payment of cash by the insurer and hence detract from its value. Similarly reserves do not add to the value of a life insurer as they represent the present value of future claims for the most part and consequently an increase in reserves lessens the present value of the company.

Contrastingly premiums are cash received and accordingly enhance the value of a life insurer. Premiums also have profit built in meaning a permanent addition to insurer value. Moreover premiums lead to the life insurer being able to reap future benefits from the policy. Investment income is cash earned by the company and thus add to its value.

Furthermore receipts (payouts) of cash allow for (constrict) a life insurer's chance of expansion and product development as well as enhance (diminish) the willingness of policyholders to buy from a company and regulators to leave the company alone and therefore the company's reputation. So as most life insurer efficiency articles apply the value added approach, it is apparent that premiums and investment income are more appropriate output proxies to utilize than are claims and (change in) reserves.

A fundamental element when exploring output proxies is the timing issue. Due to the nature of life insurance any amount drawn upon as any proxy results in a timing issue, hence its minimization is obligatory. If using claims or reserves as an output proxy the timing issue presents a greater shortcoming than if using premiums as 1) claims for the most part (if not entirely) represent the past because policyholders do not claim for several years after issue and 2) reserves, by definition, represent the future entirely.

Finally, premiums being input transposed into output is a perception exploited in some readings examining financial institutions. The first occurrence observed in the literature is in Sealey and Lindley (1977). Nonetheless, as discussed in the preceding, for life insurance commissions, sales effort, advertising, advice, underwriting, policy set-up etcetera can be seen to be input being transposed into both the initial and subsequent premiums as output.

Thinking of the procedure in the reverse direction implies that a policyholder pays premiums so that the company's employees will have tasks to undertake and thus remain employed; clearly non-sensical. Additionally the policyholder must believe that the company's functions are all operating properly or else they will not continue to pay premiums.

4.1.3. Output proxies used

With respect to the previous debate, for the reasons of 1) both reserves and claims are inappropriate output proxies, 2) premiums are more in-line with the value added approach than are reserves and claims, 3) the timing issue is less for premiums, 4) there are fundamental numerical problems when incorporating reserves or claims as an output proxy, 5) DEA is not geared to drawing upon reserves or claims as an output proxy, 6) premiums matches better to the concept of having inputs transposed into outputs, 7) mitigation effects are closer and more intuitive for premiums than for reserves, 8) premiums and/or similar values have been utilized as an output proxy from the earliest literature looking into cost and efficiency and 9) premiums are a better output proxy than is face value or policy count (see Wise (2018) for the last three items) the first of the two most prevalent sets, premiums and investment income, is the best to apply for life insurer efficiency. Hence four output proxies are used; insurance premiums, annuity premiums, accident and sickness premiums and investment income.

4.2. Input proxies

As for outputs, it is mandatory determine which quantities are best to specify as input proxies. In the life insurance company efficiency literature labor and capital are recognized by virtually all authors. The other measures used as input proxies vary somewhat with material and/or business services, or similar terminology, being most common.

One can identify a detailed list of inputs that includes 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). However the majority of life insurance efficiency studies adopt a very narrow set of input proxies as compared to this list(4) consequently they have a lack of precision which decreases the validity of their outcomes. Therefore this paper endeavors to exploit as detailed list of inputs as is feasible. Hence six input proxies are utilized; claim payments; surrender values and other payments; dividends and experience rating refunds; expenses of acquiring new business; expenses of operations with respect to existing business; and assets and interest on policyholder amounts on deposit.

5. Method

5.1. The cost function

Stochastic frontier analysis, which computes maximum output (i.e. the "frontier") that can be obtained with a given set of inputs, is used to calculate efficiency. Therefore it is compulsory to decide on the functional form to use to assess the efficient frontier. Wise (2017) shows some problems of the most common used; the translog, Fourier Flexible and Cobb-Douglas.

Notwithstanding any problems, the functional form drawn upon needs enough parameters so that the measured value is approximated reasonably "closely" to the true function. Christensen et al. (1975, pp. 381-82) and Trigo Gamarra (2008, p. 18) argue that the translog function can be thought of as a second-order Taylor approximation to any arbitrary cost function. Hence, Christensen et al. (1975) further remarks, if the data do not correspond to the demand functions derived from the translog function demand theory is false. Also the translog function is desirous being homogeneous of degree one meaning that no restriction is implied by incorporating ratios of variables to a numeraire. Accordingly the basic functional form utilized for the cost efficiency frontier is the translog function.

So employing a one-stage approach and following Berger and Mester (1997), which uses a Fourier Flexible functional form with a translog kernel, the cost function evaluated applying the translog functional form, with the time subscript suppressed for notational ease, is

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

$$\alpha_0 + \sum_{n=1}^{N} \beta_n \ln\left(\frac{w_{ni}}{w_{Ni}} - \theta_n + .001\right) + \sum_{m=1}^{M} \gamma_m \ln\left(\frac{y_{mi}}{A_i} - \theta_m + .001\right) +$$

$$\frac{1}{2}\sum_{j=1}^{N}\sum_{k=1}^{N} \delta_{jk} \ln\left(\frac{w_{ji}}{w_{Ni}} - \theta_j + .001\right) \ln\left(\frac{w_{ki}}{w_{Ni}} - \theta_k + .001\right) +$$

$$\frac{1}{2}\sum_{j=1}^{M}\sum_{k=1}^{M} \epsilon_{jk} \ln\left(\frac{y_{ji}}{A_i} - \theta_j + .001\right) \ln\left(\frac{y_{ki}}{A_i} - \theta_k + .001\right) +$$

$$\frac{1}{2}\sum_{j=1}^{N}\sum_{k=1}^{M} \zeta_{jk} \ln\left(\frac{w_{ji}}{w_{Ni}} - \theta_j + .001\right) \ln\left(\frac{y_{ki}}{A_i} - \theta_k + .001\right) +$$

$$\sum_{x=2000}^{2015} \beta_x D_{xi} + \beta_{lnasize} lnA_i + \beta_{drat} DebtRatio_i + \beta_{pnew} PercNew_i +$$

$$\beta_{mrat} MCCSRRatio_i + \beta_{dom} D_{dom\,i} + v_i + u_i \qquad (1)$$

for insurer i with C_i its cost incurred, A_i its asset value, w_i its input prices, y_i its output quantities, D_{xi} dummy variables for its years of operation, $DebtRatio_i$ its debt ratio, $PercNew_i$ its percent of new business written, $MCCSRRatio_i$ the MCCSR ratio, $D_{dom\,i}$ a dummy variable for its domesticity, 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 to be 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.

Normalization by the price of an input imposes linear homogeneity on the prices specified in the cost function and helps control for heteroskedasticity. Normalization by A_i helps control for heteroskedasticity. To show that normalizing by A_i also reduces scale biases consider the cost function. As displayed in Section 5.2 the most efficient insurer is assumed to have the lowest cost residuals u_i. In the absence of normalization it is easiest for larger companies to have lower (raw) residuals and hence be deemed to be more efficient. Therefore scaling by asset size is exploited to help control for such a scale bias (Berger and Mester, 1997).

5.2. Efficiency measurement

Following Kumbhakar and Lovell (2000) the first step in appraising cost inefficiency is to calculate the average of the residuals u_i from Equation (1) for each insurer i. Kumbhakar and Lovell (2000, p. 168) assumes that the v_i have zero expectation and constant variance accordingly the average residual is u_i^*, set as

$$u_i^* = \frac{1}{T_i}\{\sum_t ln\left(\frac{C_i}{w_{Ni}(A_i)} - \theta_C + .001\right) - \widehat{\alpha_0} - \sum_t \hat{\bullet}\ \ln(\xi)\ \} \tag{2}$$

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

$$\hat{u}_i = u_i^* - \min_i\{u_i^*\} \tag{3}$$

is evaluated and its cost efficiency is

$$CE_i = \exp(-\hat{u}_i). \tag{4}$$

The cost efficiency measure derived via equation (4) assumes that the most efficient insurer has the lowest cost residual, which is the idea incorporated by Berger and Mester (1997) found in equation (5):

$$\frac{C^{min}}{C^i} = \frac{\exp[f(w^i y^i z^i)]u_i^{*min}}{\exp[f(w^i y^i z^i)]u_i^*} = \frac{u_i^{*min}}{u_i^*} \tag{5}$$

with C the $\ln\left(\frac{C_i}{w_{Ni}A_i} - \theta_C + .001\right)$ values of the LHS of equation (1); f the functional form (here the translog function); w, y and z the input prices, output quantities and exogenous variables; and *min* the most efficient company. The idea underpinning equation (5) 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.

5.3. Profit versus efficiency

Next the crucial concept of how efficiency impacts life company profitability is investigated. Two profit values, the excess returns over Canadian Government bond yields, are utilized:

1) ROE which is defined for each year as profit/equity as in the data submitted by the insurers to the Canadian life insurance regulator, the Office of the Superintendent of Financial Institutions (OSFI) less the average ten-year Canadian Government bond yields and
2) ROA which is defined for each year as profit/assets as in the OSFI returns 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, p. 74).

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

For ROE

$$ROE_i = \beta_0 + \beta_{effy}CE_i + \sum_{x=2000}^{2015} \beta_x D_{xi} + \beta_{lnasize} lnA_i + \beta_{drat} DebtRatio_i + \beta_{pnew} PercNew_i + \beta_{mrat} MCCSRRatio_i + \beta_{dom} D_{dom\,i} \quad (6)$$

is applied for insurer i with $DebtRatio_i$ its debt ratio, $PercNew_i$ its percent of new business written, $MCCSRRatio_i$ its MCCSR ratio, D_{xi} dummy variables for its years of operation, $D_{dom\,i}$ a dummy variable for its domesticity, the β parameters to be estimated and time subscripts suppressed for notational ease. The equivalent regression is used for ROA.

The year of operation accounts for economic conditions, technological changes and where the life insurer is within the life insurance premium cycle. The (asset) size of the company is included as, for example, smaller life firms 1) cannot issue all of the types of business that larger ones can as the smaller companies may not have the expertise, statutory authority, funds available or systems and administration support; 2) cannot invest in the same types of assets as larger insurers due to less funds available to invest or a lack of statutory authority or 3) may not have the same access to reinsurance as larger insurers. Debt ratio can affect 1) whether prospective policyholders will buy; 2) in which assets a company can invest or 3) the flexibility of a company with respect to the business operations it can undertake. The percent of new business written is included as first year expenses, reserve requirements and capital requirements vastly outstrip first year premiums with the outcome of more new business decreasing the efficiency score of a life entity for up to three or five years after issue. The MCCSR ratio is included as it is an assessment of the risk the life enterprise is assuming regarding solvency and viability thus potentially inhibiting or enhancing the insurer's opportunity to create profit.

For Average ROE and efficiency

$$\overline{ROE}_i = \beta_0 + \beta_{effy} CE_i + \beta_x \overline{D}_i + \beta_{lnasize} ln\overline{A}_i + \beta_{drat} \overline{DebtRatio}_i + \beta_{pnew} \overline{PercNew}_i + \beta_{mrat} \overline{MCCSRRatio}_i + \beta_{dom} D_{dom\ i} \quad (7)$$

is incorporated for insurer i with $\overline{ROE}_i$ its Average ROE, $\overline{A}_i$ its average asset size, $\overline{DebtRatio}_i$ its average debt ratio, $\overline{PercNew}_i$ its average percent of new business written, $\overline{MCCSRRatio}_i$ its average MCCSR ratio, $D_{dom\ i}$ a dummy variable for its domesticity, the β parameters to be estimated and time subscripts suppressed for notational ease. The equivalent model is used for Average ROA.

5.4. Profit versus exogenous variables

In addition to appraising how efficiency impacts life insurance company profitability the possibility of their improving profit via the exogenous variables is determined. Evaluating how easy it is for a life insurer to change 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 8 for [percent of new business written/Average ROE], the current average is 32.49%. The change needed to increase Average ROE by one hundred basis points (bps) is quantified, applying the parameter estimate of .0063, as 158.72%; 488.6% of the current 32.49%.

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, as described after Table 8 for the percent of new business written case of ROE, the largest company/year observations are 699.5%, 283.0%, 207.5% and 192.0%. Therefore the change necessary to increase ROE by one hundred bps (47.76%) is more than 23.0% of the current amount for all except two 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 life business can improve its profit via efficiency to conclude whether to increase profit life institutions should try to improve efficiency or should try to change the value of one of its exogenous variables.

6. Data

The cost function and the profit versus efficiency parameters are estimated incorporating unbalanced panel data and generalized least squares. Fifteen years of OSFI return data, 2000 - 2004 and 2006 - 2015, are drawn on. The data are restricted to concerns licensed by OSFI to issue life insurance and do so. Companies that are only allowed to service policies or only issue reinsurance are excluded. Establishments included total forty-three domestic companies and thirty-five foreign owned companies. The measurements were implemented applying Stata version 12 as distributed by StataCorp LP.

The cost efficiency approximations require for each company i; 1) C_i, the cost incurred, 2) A_i, the asset size, 3) the prices of inputs w_{ni}, 4) the output quantities y_{mi} and 5) the exogenous variables. Fourteen company/year observations (beyond the 742 specified) were excluded due to their anomalous costs. Also a small number of the input prices and output quantities were adjusted to correct for unduly large fluctuations.

Table 1. *Summary statistics*

Company Characteristic	All Companies	Domestic Companies	Foreign Companies
Companies (N=)	78	43	35
Company/Years (N=)	742	414	328

Variable (Type)	Minimum	Maximum	Average	Standard Deviation
Primary variables ($000)				
Cost *(C)*	-1675535	12613542	387849	1157811
Asset Size *(A)*	2466	69739664	2273170	6827583
Input Prices				
Claims (w_1)	-18.130	3355.000	42.381	149.838
SVs & OPs (w_2)	-0.569	125.000	2.171	9.657
Dividends & ERRs (w_3)	-0.368	8.634	0.173	0.593
Acquiring New Business (w_4)	-55.008	28.108	0.285	2.333
Operations wrt Existing Bus (w_5)	-3.912	19.575	0.425	1.238
Assets & IPHA (w_6)	-0.001	0.184	0.004	0.008
Outputs ($000)				
LI Premiums (y_1)	-1156206	5094239	125389	409463
Annuity Premiums (y_2)	-341722	8544487	76670	381001
A&S Premiums (y_3)	-598066	2368589	87436	253812
Investment Income (y_4)	-397334	3907407	125808	397395
Profit vs Efficiency variables				
Debt Ratio *(DebtRatio)*	0.000	0.798	0.024	0.081
Percent of New Business Written *(PercNew)*	-1.136	6.995	0.310	0.417
MCCSR Ratio (*MCCSRRatio*)	0.957	144.974	3.322	7.020
ROE (Excess Return)	-1.348	5.646	0.082	0.276
ROA (Excess Return)	-0.221	1.084	0.019	0.112

Notes: Some data from potential companies and company/years not included are used in some capacity.
w_1 = value of claim payments divided by the number of claims
w_2 = value of SVs & OPs divided by their number
w_3 = value of dividends & ERRs divided by the number of these payments
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 + Single Premiums))/(net (First Year + Single Premiums + Renewal Premiums))
MCCSRRatio for domestic (foreign-owned) companies = total capital ((net) assets) available)/total capital ((net) assets) required)

7. Results and discussion

The importance of the effect efficiency has on life firm profit becomes evident upon exploring the possible ways to change profit via the exogenous variables. The conclusion is that changing efficiency may be the best, easiest and quite possibly only way to influence life insurance company profit.

7.1. Cost function parameters

The single cost function parameter estimates are shown in Table 2 (note that w_1 is the numeraire):

Table 2. *Estimates of single cost function parameters*

	Parameter Estimate	Standard Deviation			Parameter Estimate	Standard Deviation
w_2	1.4946***	0.4338		*2008*	-0.0232	0.0205
w_3	0.1771	0.2793		*2009*	-0.0007	0.0192
w_4	23.5768***	4.4421		*2010*	0.0059	0.0193
w_5	1.8296***	0.3895		*2011*	0.0193	0.0197
w_6	-1.5997*	0.8298		*2012*	-0.0107	0.0196
y_1	1.4400	2.4985		*2013*	-0.0278	0.0210
y_2	-1.6919***	0.4299		*2014*	0.0049	0.0204
y_3	6.4934***	0.8443		*2015*	-0.0172	0.0206
y_4	24.2434***	4.4106		*lnA*	0.0040	0.0030
2001	0.0175	0.0132		*DebtRatio*	-0.1864***	0.0611
2002	0.0191	0.0163		*PercNew*	0.0869***	0.0189
2003	-0.0190	0.0163		D_{dom}	-0.0289**	0.0134
2004	-0.0054	0.0165		*MCCSRRatio*	0.0029	0.0019
2006	-0.0083	0.0183		α_0	-1.8266	3.4874
2007	-0.0192	0.0189				

*** = significant to a 1% level.
** = significant to a 5% level.
* = significant to a 10% level.
Notes: 1) 2000 is the base year so the year variables represent the change due to operating in that year vs. 2000. 2) For the cross-variable parameter estimates contact the author.

Six of the nine single price and output variables have parameter estimates with a significance of one percent or less and another has a parameter estimate with a significance of six percent. All of the input prices, except for the price of assets and interest on policyholder amounts on deposit have parameter estimates greater than zero; intuitively correct. The estimates for each of life insurance, accident and sickness and investment income output are positive; all intuitively correct as cost increases with all of these types of business. Two of the five non-year exogenous variable parameter estimates are within the one percent level of significance and one other is within the five percent level of significance. The percent of new business written and D_{dom} parameter estimates are positive and negative, respectively; both intuitively correct. Such results tend to show the cost function is valid.

7.2. Parameter estimates and changing profit

This section exhibits the effect that cost efficiency and the other variables have on life insurer 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 (and a fifty bp for ROE) improvement in the respective profit measures. Whether it is possible, difficult or impossible for an insurer to increase each using each exogenous variable (except domesticity) is also determined. These outcomes are then compared to how easily a life insurance company can improve its profit via efficiency to conclude whether a LIC should try to improve efficiency to increase profit or should try to change the value of one of the exogenous variables.

The parameter estimates obtained from models (6) and (7) for 1) efficiency, 2) the (natural log of) asset size, 3) the debt ratio, 4) the percent of new business written, 5) the MCCSR ratio and 6) domesticity are mostly consistent as to their sign and statistical significance as seen in Table 4:

Table 4. *Parameter Estimates and Statistical Significance Values*

Parameter	Estimate	Parameter	Estimate	Parameter	Estimate
Efficiency		Debt Ratio		MCCSR Ratio	
ROE	0.0448	ROE	-0.2514***	ROE	0.0001
Average ROE	0.4060***	Average ROE	-0.5082***	Average ROE	-0.0004
ROA	0.0666***	ROA	-0.1342***	ROA	-0.0001
Average ROA	0.1870***	Average ROA	-0.0675**	Average ROA	0.0011
Ln(Asset Size)		PNB		Domesticity	
ROE	0.0047**	ROE	-0.0209**	ROE	0.0804***
Average ROE	0.0115***	Average ROE	0.0063	Average ROE	0.0776***
ROA	-0.0067***	ROA	-0.0071***	ROA	0.0168***
Average ROA	-0.0046***	Average ROA	-0.0218***	Average ROA	0.0081

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

The consistency of the sign and significance of the parameter estimates found in Table 4 tends to demonstrate that the models (6) and (7) are valid. As well in Table 4 the Average ROE and Average ROA assessments represent the 742 company/year observations spread over seventy-eight companies and thus an average of over nine and one-half and up to fifteen 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 of the Average ROE and Average ROA evaluations may be a better indicator of reality concerning life insurance because it is a long-term proposition. Consequently the fact that the efficiency parameter estimates in Table 4 are higher for the average profit computations shows that efficiency is even more vital to life enterprises in the more critical long-term than in the short-term. In addition the conclusion from the preceding combined with Tables 5 through 10 is that the best, easiest and quite possibly only way for a life insurer to influence profit is through changing its efficiency.

7.2.1. Changing profit using efficiency

To illustrate, first consider how easy it is for a life insurance company to change profit using cost efficiency. Table 5 displays the parameter estimates, and the changes necessary regarding efficiency to increase the profit measures by one hundred basis points (and fifty basis points for ROE):

Table 5. *Values relating to increasing profit measures: efficiency*

Profit Measure	Value		Notes
ROE	Parameter Estimate	0.0448	
	Change Necessary: 100 bps	22.33%	14 of 78 LICs have inefficiency < 22.33%
	Change Necessary: 50 bps	11.17%	5 of 78 LICs have inefficiency < 11.17%
	Average Inefficiency	26.22%	
Average ROE	Parameter Estimate	0.4060***	
	Change Necessary: 100 bps	2.46%	1 of 78 LICs has inefficiency < 2.46%
	Average Inefficiency	26.15%	
ROA	Parameter Estimate	0.0666***	
	Change Necessary: 100 bps	15.02%	9 of 78 LICs have inefficiency < 15.02%
Average ROA	Parameter Estimate	0.1870***	
	Change Necessary: 100 bps	5.35%	3 of 78 LICs have inefficiency < 5.35%

*** = significant to a 1% level

As per equation (5) of Section 5.2, the efficiency calculated assumes the firms do not change their set of input prices, outputs and exogenous variables. Accordingly as is apparent from Table 5, decreasing inefficiency by the amount necessary to increase any of the profit measures by one hundred bps is clearly possible. For the worst case, ROE, the average inefficiency is 26.22% and the change necessary to increase ROE by one hundred bps is 22.33%. However, as only fourteen of the seventy-eight companies have an inefficiency of less than 22.33%, it seems possible to increase ROE using efficiency. Looking into changing profit by fifty bps the change necessary to increase ROE is 11.17% therefore such a change looks possible as only five of seventy-eight companies have an inefficiency less than 11.17%.

In contrast to easily being able to change profit via efficiency, the results below exhibit life companies cannot easily change profit by changing one of the other business aspects that can be controlled.

7.2.2. Changing profit using asset size

The first such aspect analyzed concerns how easily a life insurer can change profit via asset size. Table 6 shows the parameter estimates, and the changes necessary regarding the natural log of asset size to increase the profit measures by one hundred basis points (and fifty basis points for ROE):

Table 6. *Values relating to increasing profit measures: Ln(asset size)*

Profit Measure	Value	
ROE	Parameter Estimate	0.0047**
	Change Necessary: 100 bps	2.144
	Change Necessary: 50 bps	1.072
Average ROE	Parameter Estimate	0.0115***
	Change Necessary: 100 bps	0.867
ROA	Parameter Estimate	-0.0067***
	Change Necessary: 100 bps	-1.483
Average ROA	Parameter Estimate	-0.0046***
	Change Necessary: 100 bps	-2.187

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

Table 6 demonstrates that to change one of the profit measures by one hundred bps (or ROE by fifty bps) necessitates an insurer changing its natural log of asset size by a positive quantity of at least 0.867 or a negative quantity of at most -1.483. This equates to increasing asset size by at least 238% or decreasing it by at least 77%, both clearly impossible.

7.2.3. Changing profit using debt ratio

Only 101 company/year observations have a positive debt ratio so the investigation is also executed for those alone.

Table 7 illustrates the parameter estimates, and the changes necessary regarding debt ratio (as well as only companies with a positive debt ratio) to increase the profit measures by one hundred basis points (and fifty basis points for ROE):

Table 7. *Values relating to increasing profit measures: Debt Ratio (DR)*

Profit Measure	Value		% Required Change is of Current Average DR
ROE	Parameter Estimate	-0.2514***	
	Necessary DR: All Companies 100 bps	-1.54%	
	Necessary DR: DR >0 Only 100 bps	13.97%	22.2%
	Necessary DR: All Companies 50 bps	0.45%	81.4%
	Necessary DR: DR >0 Only 50 bps	15.95%	11.1%
	Current Average (All)	2.44%	
	Current Average (DR>0)	17.94%	
Average ROE	Parameter Estimate	-0.5082***	
	Necessary DR: All Companies 100 bps	1.56%	55.8%
	Necessary DR: DR >0 Only 100 bps	10.53%	15.7%
	Current Average (All)	3.53%	
	Current Average (DR>0)	12.50%	
ROA	Parameter Estimate	-0.1342***	
	Necessary DR: All Companies 100 bps	-72.08%	
	Necessary DR: DR >0 Only 100 bps	-56.58%	
Average ROA	Parameter Estimate	-0.0675**	
	Necessary DR: All Companies 100 bps	-11.28%	
	Necessary DR: DR >0 Only 100 bps	-2.31%	

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

Notes: For positive necessary DRs the right-most column has the percent that the needed change is, of the current average DR, to achieve the necessary DR. For example for ROE/100 bps/>0, the average is 17.94% so achieving the necessary DR of 13.97% requires a change of 3.98% which is 22.2% of the current 17.94%.

Table 7 displays that debt ratio has a negative effect on both ROE and ROA; in line with expectations. Plus for changing profit Table 7 exhibits that for 1) all companies and 2) only companies with positive debt ratio, to change a profit measures by one hundred bps necessitates an insurer changing its debt ratio either to 1) a negative amount which is impossible or 2) a positive amount that is difficult or impossible for the insurer to obtain. For the latter the smallest change necessary is 11.1% of the current value, which is difficult for an insurer to realize.[(5)]

Average inefficiency has reduced insurer ROE by 16.5% and to regain this by changing a company's debt ratio necessitates decreasing it by 65.6%, clearly impossible, even for company/year observations greater than zero as these have a current average debt ratio of 17.9%. (See the Appendix for the values corresponding to the profit measures not referred to in the text for each of debt ratio, percent of new business written and MCCSR ratio for profit reductions due to average inefficiency and regarding specific company/years and companies).

The prior explanation is for averages only. The same conclusions apply for the specific company/year observations. For example changing ROE by one hundred (fifty) bps requires the entity to sell more than 9.0% of current debt for all but three (thirty-two) of 742 company/year observations.

7.2.4. Changing profit using percent of new business written

Table 8 shows the parameter estimates, and the changes necessary regarding the percent of new business written by the company to increase the profit measures by one hundred basis points (and fifty basis points for ROE):

Table 8. *Values relating to increasing profit measures: Percent of New Business Written (PNB)*

Profit Measure	Value		% Required Change is of Current Average PNB
ROE	Parameter Estimate	-0.0209**	
	Necessary PNB: 100 bps	-16.75%	
	Necessary PNB: 50 bps	7.12%	77.0%
	Current Average	31.01%	
Average ROE	Parameter Estimate	0.0063	
	Necessary PNB: 100 bps	191.2%	488%
	Current Average	32.49%	
ROA	Parameter Estimate	-0.0071***	
	Necessary PNB: 100 bps	-110.14%	
Average ROA	Parameter Estimate	-0.0218***	
	Necessary PNB: 100 bps	-13.40%	

*** = significant to a 1% level.
** = significant to a 5% level.
Notes: For positive necessary PNBs the right-most column shows the percent that the required change is, of the current average, to achieve the necessary PNB. For example, for Avg ROE, the average PNB is 32.49% so attaining the needed PNB of 191.2% requires a change of 158.72%; 488.6% of the average 32.49%.

Table 8 illustrates that, using the parameter estimates, changing one of the profit measures by one hundred bps necessitates a life insurance company changing its percent of new business written either to 1) a negative amount which is impossible or 2) an impossible positive amount as the smallest change necessary (to change ROE by fifty bps) is increasing the percent of new business written by 77% of the current value. As well, average inefficiency has reduced ROE by 16.5%; to regain this by changing percent of new business written necessitates decreasing it to less than -750%, clearly impossible.

The above scrutinizes averages only. The same conclusions are valid regarding the specific company/year observations. For example to change ROE by one hundred (fifty) bps the company has to decrease the amount of percent of new business written by greater than 23.0 (21.4%) of the current value for all except two (six) of 742 company/year observations.

7.2.5. Changing profit using MCCSR ratio

Table 9 exhibits the parameter estimates, and the changes necessary regarding the MCCSR ratio to increase the profit measures by one hundred basis points (and fifty basis points for ROE). As none of the estimates have significance the ends of the 95% confidence intervals are also explored.

Table 9. *Values relating to increasing profit measures: MCCSR ratio*

Profit Measure	Change Sought and Current Averages	Parameter Estimate	Lower End of 95% CI	Upper End of 95% CI
ROE		0.0001	-0.0009	0.0012
	100 basis points	83.838 (2423%)	-7.755	12.010 (261.5%)
	50 basis points	43.580 (1212%)	-2.217	7.666 (130.7%)
	Current Average	3.322		
Average ROE		-0.0004	-0.0030	0.0023
	100 basis points	-25.338	-0.679	6.974 (264.8%)
	Current Average	2.634		
ROA		-0.0001	-.0007	.0004
	100 basis points	-82.515	-11.841	26.769 (705%)
Average ROA		0.0011	-0.0023	0.0046
	100 basis points	11.548 (338.4%)	-1.618	4.810 (82.6%)

Note: For positive necessary ratios the parentheses have the percent the required change is, of the average ratio, to achieve the needed ratio. For example, for ROE/100 bps/Parameter Estimate, the current average is 3.322 so attaining the needed ratio of 83.838 requires a change of 80.515; 2423% of the current 3.322.

Table 9 demonstrates that the MCCSR ratio parameter estimates are all near zero; intuitively correct as it is hard to predict whether funds not incorporated toward the ratio would earn a higher profit than if they were. In addition Table 9 displays that, when examining any of the parameter estimates or ends of the 95% confidence intervals, to change one of the profit measures by one hundred bps necessitates an insurer changing its MCCSR ratio to an amount that is difficult or impossible for the insurer to obtain. The smallest change necessary (Average ROA/100 bps/Upper End) is increasing the MCCSR ratio by 82.6% of the current value, which is difficult for a business to achieve.

The foregoing considers averages only. The same conclusions are true with respect to the specific company/year observations. For example to change ROE by one hundred (fifty) bps using the parameter estimate the company has to increase its MCCSR ratio by more than 111 (104)% of the current amount for all but one (three) of 742 company/year observations.

7.2.6. Domesticity and profit

The domesticity parameter estimates of Table 4 illustrate that Canadian-owned life companies are more profitable than are foreign-owned. The result is intuitive due to 1) the extra bureaucracy associated with being a foreign-owned company, 2) learning costs concerning regulations, 3) a prejudice against buying from a foreign company, 4) information problems leading to, e.g., adverse selection or moral hazard and 5) higher costs, such as for coordination and monitoring quality or management, from being a distance from head office.

7.3. Feasibility of increasing profit

The results of Tables 4 through 9 are used to determine the feasibility of a life insurance company realizing a one percentage point (one hundred basis point) improvement in the profit measures by altering each independent variable that a life insurer can control in (6) and (7). Table 10 summarizes.

Table 10. Feasibility of increasing profit via the independent variables

Variable & profit measure	Feasibility	Variable & profit measure	Feasibility
Efficiency		Debt Ratio (DR)	
ROE (100 bps)	Possible	ROE (100 bps)	Impossible
ROE (50 bps)	Possible	ROE (50 bps)	Impossible
Average ROE	Possible	Average ROE	Impossible
ROA	Possible	ROA	Impossible
Average ROA	Possible	Average ROA	Impossible
Ln(Asset Size)		DR >0 Only	
ROE (100 bps)	Impossible	ROE (100 bps)	Difficult
ROE (50 bps)	Impossible	ROE (50 bps)	Difficult
Average ROE	Impossible	Average ROE	Difficult
ROA	Impossible	ROA	Impossible
Average ROA	Impossible	Average ROA	Impossible
Percent New Business (PNB)		DR Company/Years	
ROE (100 bps)	Impossible	ROE (100 bps)	Difficult/Impossible
ROE (50 bps)	(Virtually) Impossible	ROE (50 bps)	Difficult/Impossible
Average ROE	Impossible	Average ROE	Difficult/Impossible
ROA	Impossible	ROA	Impossible
Average ROA	Impossible	Average ROA	Impossible

Variable & profit measure	Feasibility	Variable & profit measure	Feasibility
PNB Company/Years			
ROE (100 bps)	Difficult/Impossible		
ROE (50 bps)	Difficult/Impossible		
Average ROE	Impossible		
ROA	Impossible		
Average ROA	Impossible		
MCCSR Ratio	Parameter Estimate	Lower 95% CI	Upper 95% CI
ROE (100 bps)	Impossible	Impossible	Impossible
ROE (50 bps)	Impossible	Impossible	Impossible
Average ROE	Impossible	Impossible	Impossible
ROA	Impossible	Impossible	Impossible
Average ROA	Difficult	Impossible	Impossible
MCCSR Company/Years			
ROE (100 bps)	Impossible	Difficult	Difficult
ROE (50 bps)	Impossible	Difficult	Difficult
Average ROE	Impossible	Impossible	Difficult
ROA	Impossible	Difficult	Impossible
Average ROA	Impossible	Difficult	Difficult

Note: Company/years refers individual company/year observations. For example for DR/ROA, for all 742 company/year observations the needed change is more than 93% of the current value, deemed impossible.

The main conclusion to draw from Table 10 is that it is either difficult or impossible to for a life insurer to improve its profit by changing one of its business characteristics that can be controlled (other than cost efficiency). Therefore the best, easiest and quite possibly only way for life insurance companies to influence profit is through improving efficiency.

8. Conclusions

The key conclusion reached from Tables 6 to 10 and Tables A1 to A5 is that to increase profit, or regain the profit lost due to inefficiency, a life insurance company must change one of the business aspects it can control (other than efficiency) enough to be difficult to accomplish or finds it impossible. In contrast Tables 5 and 10 illustrate that to increase profit using efficiency is definitely possible. The two ideas are true for increasing the profit measures by 100 bps and even for increasing ROE by 50 bps. Thus, especially in the vital long-term, the best, easiest and quite possibly only way for life insurance companies to influence profit is through improving efficiency.

Other important conclusions are that the sign and significance of the parameter estimates in Table 4 being consistent tends to demonstrate that models (6) and (7) are valid. Secondly, the efficiency parameter estimates in Tables 4 and 5 are higher for the average profit measures, indicating that efficiency is a critically greater determinant of profit in the more realistic long-term than in the short-term. The latter indicates that a life insurance company should pay strict attention to efficiency as it is a central element of the life insurance business.

The greater long-term influence is also shown with the short-term cases having potential ROE (ROA) reduced by 16.5% (35.1%) due to average inefficiency whereas for the long-term cases the reductions were potential Average ROE by 55.4% and potential Average ROA by 55.9%.

For the company/year observations an average of 16.3 (34.4)% of potential short-term ROE (ROA) is lost due to inefficiency when excluding observations that have a negative profit before the drop due to inefficiency. For the long-term cases the average loss in potential profit lost is 54.4 (53.2%) for Average ROE (ROA) when excluding observations that have a negative profit before the inefficiency drop. Furthermore for the short-term (long-term) cases, 19.3% to 32.9% (83.3% to 84.0%) of the individual company/year observations (companies) with a negative profit would have a positive profit if inefficiency were removed.

Life insurance is a long-term proposition so the long-term results exhibited above are more crucial than the short-term results. Consequently the preceding demonstrating that in all features examined the long-term influence is greater than the short-term influence of efficiency on profit is important. As well the greater long-term influence shows that the conclusions concerning the effect of efficiency and other variables on profit, namely that the best, easiest and quite possibly only way for life insurance companies to influence their profit is through improving their efficiency, are especially true in the vital long-term.

Notes

(1) A recent example is that of American International Group whose financial difficulties and near bankruptcy played a key role in and helped lead to the "Global Financial Crisis" that began in 2008. For more details see Baranoff (2012), The Financial Crisis Inquiry Commission (2011), Mishkin (2011) and Sjostrom (2009).

(2) The rankings are from Swiss Reinsurance Company Limited (SRC) (2016) and SRC (2017) and are subject to the caveats therein, e.g. that the Canada life insurance premiums in the tables are (valuation) net premiums. The per capita ranking considers countries with a population of more than six (five) million.

(3) Treating life insurance and general insurance as one is a problem as they are inherently distinct, e.g., 1) general insurance claims can repeat whereas mostly not with life insurance, 2) a substantial part of life insurance business is annuities involving payments with no occurrence of a contingent event while such payments are much smaller for general insurance, 3) life insurance business tends to be long-term with general insurance tending to be short term and 4) the regulations, capital requirements, etcetera of the two are (vastly) different.

(4) Of the studies perused only twenty-four percent use more than three input proxies.

(5) Recall that debt ratio = Debt/(Debt + Equity) so changing it by 11.1% equates to changing debt by 13.2%.

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Appendix

From Section 7.2.3 Table A.1 shows the decreases in profit due to average inefficiency and the changes in debt ratio necessary to regain the decrease. For each profit measure the change necessary is impossible. Table A.2 shows the necessary change in the current debt of the individual company/years or companies to increase profit by 100 bps (and 50 bps for ROE). In each case the change is difficult or impossible for most.

Table A.1. *Values concerning decreasing profit due to average inefficiency: Debt Ratio*

Profit Measure	Value	
ROE	Decrease due to Average Inefficiency	16.5%
	Necessary Change to Regain: Parameter Estimate	-65.6%
	Current Average of Company/Years (All Companies)	2.44%
	Current Average of Company/Years (DR>0 Only)	17.94%
Average ROE	Decrease due to Average Inefficiency	55.4%
	Necessary Change to Regain: Parameter Estimate	>100%
	Current Average of Company/Years (All Companies)	3.53%
	Current Average of Company/Years (DR>0 Only)	12.50%
ROA	Decrease due to Average Inefficiency	35.1%
	Necessary Change to Regain: Parameter Estimate	>2600%
Average ROA	Decrease due to Average Inefficiency	55.9%
	Necessary Change to Regain: Parameter Estimate	>800%

Table A.2. *Percent of current debt ratio change necessary to increase profit*

Profit Measure	Change	Notes Regarding the 742 Company/Years or the 78 Companies
ROE	100 bps	Must change DR by >9.0% of current DR for all but 3 company/years
	50 bps	Must change DR by >8.0% of current DR for all but 21 company/years
	50 bps	Must change DR by >9.0% of current DR for all but 32 company/years
	50 bps	Must change DR by >10.0% of current DR for all but 40 company/years
Average ROE	100 bps	Must change DR by >10.1% of current DR for all but 6 LICs
ROA	100 bps	Must change DR by >93% of current DR for all company/years
Average ROA	100 bps	Must change DR by >38% of current DR for all LICs

From Section 7.2.4 Table A.3 has the decreases in profit due to average inefficiency and the percent of new business written necessary to regain the decrease. For each profit measure the change necessary is impossible. Table A.4 shows the necessary change in the current percent of new business written of the individual company/years or companies to increase profit by 100 bps (and 50 bps for ROE). In each case the change is difficult or impossible for most.

Table A.3. *Values concerning decreasing profit due to average inefficiency: percent of new business written*

Profit Measure	Value	
ROE	Decrease due to Average Inefficiency	16.5%
	Necessary PNB to Regain: Parameter Estimate	<-750%
	Current Average: All Companies	31.0%
Average ROE	Decrease due to Average Inefficiency	55.4%
	Necessary PNB to Regain: Parameter Estimate	>8800%
	Current Average: All Companies	32.5%
ROA	Decrease due to Average Inefficiency	35.1%
	Necessary PNB to Regain: Parameter Estimate	<-4900%
Average ROA	Decrease due to Average Inefficiency	55.9%
	Necessary PNB to Regain: Parameter Estimate	<-2500%

Table A.4. *Percent of current PNB change necessary to increase profit*

Profit Measure	Change	Notes Regarding the 742 Company/Years or the 78 Companies
ROE	100 bps	Must decrease by >23.0% of current PNB for all but 2 company/years
	50 bps	Must decrease by >21.4% of current PNB for all but 6 company/years
Average ROE	100 bps	Must increase by >100% of current PNB for all LICs
ROA	100 bps	Must decrease by >49.8% of current PNB for all but 1 company/year
Average ROA	100 bps	Must decrease by >45% of current PNB for all LICs

From Section 7.2.5 Table A.5 shows the necessary change in the current MCCSR Ratio of the individual company/years or companies to increase profit by 100 bps (and 50 bps for ROE). Values for the parameter estimate and each end of the 95% confidence interval are shown. In each case the change is difficult or impossible for most.

Table A.5. *Percent of current MCCSR change necessary to increase profit*

Profit Measure	Estimate	Notes Regarding the 742 Company/Years or the 78 Companies
ROE	Parameter Est	
	100 bps	Must increase by >111% of current ratio for all but 1 company/year
	50 bps	Must increase by >104% of current ratio for all but 3 company/years
	Lower End	
	100 bps	Must decrease by >28.6% of current ratio for all but 3 company/years
	50 bps	Must decrease by >26.5% of current ratio for all but 7 company/years
	Upper End	
	100 bps	Must increase by >22.4% of current ratio for all but 3 company/years
	50 bps	Must increase by >20.8% of current ratio for all but 7 company/years
Average ROE (100 bps)	Parameter Est	Must decrease to < zero for all LICs
	Lower End	Must decrease by >40.4% of current ratio for all but 1 LIC
	Upper End	Must increase by >21.2% of current ratio for all LICs
ROA (100 bps)	Parameter Est	Must decrease to < zero for all but 1 company/year
	Lower End	Must decrease by >21.2% of current ratio for all but 1 company/year
	Upper End	Must increase by >32.5% of current ratio for all but 1 company/years
Average ROA (100 bps)	Parameter Est	Must increase by >43.5% of current ratio for all LICs
	Lower End	Must decrease by >20.7% of current ratio for all LICs
	Upper End	Must increase by >26.5% of current ratio for all but 1 LIC