“Life insurance company efficiency: best method and proxies”

AUTHORS	William Wise https://orcid.org/0000-0001-8947-2351

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William Wise, MActSt & M.A. (Mathematics), School of Actuarial Studies, University of New South Wales, Australia.

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William Wise (Australia)

LIFE INSURANCE COMPANY EFFICIENCY: BEST METHOD AND PROXIES

Abstract

Life insurance is a very important segment of the economy of most countries as demonstrated by the investments, premium revenue and numbers employed. Hence, it is paramount to determine accurately how well life insurance companies (LICs) perform and how viable they are for the benefit of both other industries and national economies.

Three papers that investigate LIC efficiency directly analyze how efficiency affects LIC profits. One critical feature is that they show that the inefficiency of LICs can greatly affect their (financial) outcome and ultimately their survivorship. Thus, said research clearly indicates that life insurer efficiency is a crucial area to investigate and assess and that it could greatly enhance the ability to properly monitor and inspect the life insurers.

This article co-ordinates information regarding life insurance efficiency studies to help researchers learn which approaches, methods and output/input proxies to use. While some papers do so for some of the aspects that are important and necessary for life insurance efficiency studies, this is the first to deal with said aspects together. More specifically, this paper especially considers and evaluates the different methods and output proxies used in life insurance efficiency studies, as they seem to be the elements where the most disagreement exists between researchers. In addition, this article is unique in examining how input (proxy) prices are used in life insurance efficiency studies.

Keywords life insurance, efficiency, parametric/nonparametric methods, outputs/inputs

JEL Classification G22, H21, G28

INTRODUCTION

The role of the financial sector in the economic development of any country is very significant (Janjua & Akmal, 2015). Therefore, an effective and productive insurance sector ultimately contributes to a nation's economic growth (State Bank of Pakistan, 2005; Insurance Europe, 2015). 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 national economies.

This article co-ordinates information regarding life insurance efficiency studies to help researchers discover which methods and output/input proxies to use. While some papers do so for some aspects that are important and necessary for life insurance efficiency studies, this is the first to deal with said aspects together. More specifically, this paper especially considers and evaluates the different methods and output proxies used in life insurance efficiency studies, as these seem to be the elements where the most disagreement exists. In addition, this article is unique in examining how input (proxy) prices are used in life insurance efficiency studies.

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Three papers that investigate LIC efficiency (Greene & Segal, 2004; Karim & Jhantasana, 2005; Alhassan & Addison, 2013) directly analyze how efficiency affects LIC profits. One critical feature of these articles is that they show that the inefficiency of LICs can greatly affect their (financial) outcome and ultimately their survivorship. Thus, said research indicates that life insurance efficiency is a crucial area to investigate and that it could greatly enhance the ability to properly monitor life insurers.

Section 1 continues with a justification of why life insurance and studying its efficiency are important, section 2 presents a review of the literature written with respect to the methods along with the output and input proxies and prices used in LIC efficiency studies. Section 3 follows with a detailed explanation of output proxies and which are (in)appropriate, and the last section concludes.

1. IMPORTANCE OF LIFE INSURANCE

That life insurance is essential to a well-functioning economy of most developed countries is demonstrated by its investments, premium revenue and numbers employed. In the United States in 2015, the life insurance industry had invested $6.2 trillion (Tr) in the assets (American Council of Life Insurers (ACLI), 2016). The corresponding value in 2015 for Canada is CAD 726 billion (B) (Canadian Life and Health Insurance Association (CLHIA), 2016) and for Europe in 2013 is €6948 billion (Insurance Europe, 2014). In 2015 in Asia ex-Japan $2.4 trillion USD and in Japan over ¥360 trillion was invested by the life insurance industry (China Money Network, 2014; The Life Insurance Association of Japan, 2016). In 2016, more than USD 2.6 trillion in premium was generated by the life insurance industry worldwide with over $831 billion in the United States (in 2015), over USD 1 trillion in Asia and over USD 858 billion in Europe (ACLI, 2016; Swiss Reinsurance Company Limited, 2017).

Furthermore, in the United States in 2015, more than 2.5 million people worked in the life insurance industry (ACLI, 2016) and in Europe in 2015, there were more than 650,000 direct and 650,000 indirect employees in the insurance industry (Insurance Europe, 2015; Insurance Europe, 2016).

Life insurance is also important, as the insurance industry is vital to the wellbeing of other industries, households and a nation's overall economy (Davidson, 2001; Grace & Klein, 2008). Therefore, 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 (Yacoubi & Beauchemin, 2014). Additionally, such a bankruptcy can harm the confidence of all stakeholders concerned in the insurance industry (Llewellyn, 2005; Yasui, 2001) and the entire financial services industry, 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 significant banking and derivative activities (The Geneva Association Systemic Risk Working Group, 2010). Consequently, such damage can lead to a decrease in insurance coverage, and so protection for both business and the public at large, and missed investment opportunities, which will further hurt the economy of a country.

Because most LIC products are of a long-term nature, policyholders have a large sensitivity to and dependency on company survival (Bikker, 2012; Llewellyn, 2005). Hence, an insurer bankruptcy can have a ruinous effect on its policyholders, because they then have nothing to show for their paid premiums due to the product of a LIC being a promise for future payment. Consumers find it difficult to make rational choices regarding the value of policies, because it can only be evaluated after purchase (Llewellyn, 2005).

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 critical to the wellbeing of other industries,

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).

households and a nation's overall economy and 3) policyholders having have a large sensitivity to and dependency on company survival, it is critical that regulators and other stakeholders evaluate the profitability and viability of LICs correctly and properly.

Now, efficiency is a key determinant of a company's viability in that it represents the company's capability to generate outputs (such as premiums and investment income) using inputs (such as administrative and sales staff and financial capital) (Farrell, 1957; Shephard, 1970) and an entity is efficient if it is not possible to improve any of its inputs or outputs without worsening some of its other inputs or outputs (Koopmans, 1951; Lovell, 1993). An alternative concept is that in estimating its efficiency, each business in an industry is compared to a "best practice" efficient frontier with scores varying between zero and one; an idea generally held to be introduced by Debreu (1951) and Farrell (1957). Consequently, as efficiency is a measure of the deviation between the actual performance 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 efficient performance is essential for a company to survive. Indeed, with respect to insurance, assessing efficiency helps insurance companies improve their service quality and solve their problems (Kueng, 2000).

It is apparent from the preceding that as life insurance is very important and efficiency is a crucial determinant of how well life insurers do, life insurer efficiency is a significant area to research and it is fundamental to evaluate it accurately. Critical elements to consider are the 1) method applied and 2) quantities utilized to measure proxy outputs and inputs.

2. LITERATURE REVIEW

2.1. Best method to use to measure LIC efficiency

There are seven methods most commonly used to estimate life insurer efficiency; two nonparametric, three parametric, one semiparametric and the Bayesian (Wise, (2017) for a description of the methods along with their advantages and disadvantages with respect to evaluating LIC efficiency).

Wise (2017) elucidates the reasons that the nonparametric methods are inappropriate for LIC efficiency research, mainly 1) the assumption of no random error, 2) the assumption of available inputs being similar across all decision making units (DMUs), 3) being designed for DMUs that do not have the usual economic goals such as profit maximization or cost minimization, 4) the calculation being very susceptible to the number of exogenous constraints used, 5) an inability to calculate allocative efficiency scores and 6) firms can have very high efficiency scores simply because few others have analogous inputs, outputs or related observations.

The Bayesian approach is rarely used in LIC efficiency measurement and it has several deficiencies such as 1) a necessity to choose a reasonable prior *pdf* without which the estimates with respect to each β_k may be useless or nonsensical, 2) the prior *pdf* is chosen by the researcher possibly leading to inherent problems such as a bias or error in their beliefs and 3) a potential difficulty in calculating the marginal *pdfs*.

Wise (2017) remarks upon the several shortcomings regarding the most commonly specified semi-parametric method of incorporating a FF functional form, mainly 1) its sine and cosine functions have no economic interpretation, 2) said functions do not satisfy the usual regularity conditions, 3) it can overfit the data and 4) it may have poor predictive ability.

Furthermore, as seen in Wise (2017), there are also drawbacks with some parametric methods. As to the distribution free approach (DFA), there is 1) an assumption of no random error and 2) a measurement of each firm's average inefficiency over time as opposed to each point in time. A second parametric method, thick frontier analysis (TFA), 1) only evaluates the overall efficiency of an industry, as opposed to that of each DMU, 2) uses data that may bias the coefficient estimates and 3) requires data that are highly dispersed.

Wise (2017) additionally cites that the parametric methods have the advantages 1) corresponding

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to the disadvantages of the nonparametric methods, 2) of absorbing some effect of heterogeneity in inputs and outputs, 3) of facilitating statistical testing of hypotheses and 4) of calculation of confidence intervals. Specifically, stochastic frontier analysis (SFA) has the key advantages that it 1) can differentiate between efficiencies and measurement error, 2) exhibits internal consistency and 3) is easy to apply. The result of the above discussion is that it is clear that the SFA is the best method to adopt for the measurement of LIC efficiency.

2.2. Output proxies: reserves and claims

There is a debate in the literature as 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[2], Wise (2017) lists reasons given for using (change in) reserves as 1) it is the best proxy for underwriting, claims handling and other 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 because of the idea that the reserve equals the asset value of a company.

Claims, also referred to as incurred benefits, is linked with reserve (changes) as an output proxy. Wise (2017) presents reasons as 1) claims measure the amount of funds pooled and redistributed (i.e. for losses) by insurers, 2) said redistribution is the object of risk-pooling[3], 3) claims equal current expenses and losses, 4) claims proxy real services as highly correlated with loss amounts and 5) claims are a better measure of output than are premiums as insured do not really understand pricing and hence pay "wrong" premiums (Doherty, 1981, p. 393). Doherty (1981) furthers its opinion of claims being a better output proxy than is premiums by postulating that utilizing premiums leads to a systematic error when compared to the true output and claims does not.

2.3. Output proxies: premiums and investment income

With respect to using premiums as an output proxy, the earliest literature regarding financial institution costs incorporated measures such as loans, investments and deposits as proxies for output with the justification that these measures gave an accurate assessment of the size of the firm or its production (Gilbert, 1984; Rasiah, 2010). The earliest papers read 1) use the ratio of a) loans plus investments to total assets or b) utilize capacity to total capacity as an index of the efficiency of banks; 2) determine costs per bank size, measured as dollars of deposits; 3) draw upon total deposits as a proxy for bank size; and 4) note that "loans and investments are the banking output most nearly analogous to the product of the manufacturing firm" (Alhadeff, 1954; Schweiger & McGee, 1961; Gramley, 1962; Horvitz, 1963, p. 4).

This moved to applying total revenue of and numbers of accounts serviced. Most financial institution costs studies investigated specify either one of these measures or some combination of them as output proxies. Examples include Berger, Hanweck, and Humphrey (1987) and Berger and Humphrey (1992a, p. 250) which affirms that "the major categories of produced deposits (demand, time and savings) and loans (real estate, commercial, installment) [are] important outputs, because they are responsible for the great majority of value added".

For insurance, the same views were also expressed initially with premiums corresponding to loans, investments and deposits. For risk products, Wise (2017) cites the early papers of Blair, Jackson, and Vogel (1975) and Diewert (1995). Annuities and accident and sickness are inherently different from life insurance, so can be considered separately when deciding upon suitable proxies[4]. Segal (2002, p. 84) advocates using premiums as an output proxy for each. Whereas the foregoing discus-

2 Some studies use expenses as the main output proxy, e.g. Hirshhorn and Geehan (1977) Geehan (1977), Weiss (1986) and O'Brien (1991). Therefore, they use the user cost approach, which involves difficult calculations and data gathering.

3 Cummins and Rubio-Misas (2001, p. 10) and Tone and Sahoo (2005, p. 272) explicitly state this, but the papers using the idea that claims represent payments received by policyholders and are good proxies, as they measure the amount of funds pooled and redistributed (i.e. for losses) by insurers, implicitly state it.

4 As annuities provide payment on life, while life insurance provides payment on death (among several other reasons). As, for example, with A&S, the payment can be on sickness (not death), the payment can be continuing (as opposed to lump sum), the premiums are constant, and the methods used for pricing and valuation are different.

sion shows that from the beginning, cost and efficiency writers have designated premiums and/or related measures as a proper output proxy, some papers including Greene and Segal (2004), Saeidy and Kazemipour (2011) and Bawa and Bhagat (2015) suggest output proxies similar to premiums such as policy count and face value (FV). Wise (2017) remarks on reasons given including that 1) premium increases influence the output amounts, 2) premiums are revenue, not quantity of output as they are the product of price and quantity, 3) premium differences can exist between large and small insurers and 4) premiums being appropriate for output necessitates products to be homogenous and sold at the same price (Allen, 1974; Blair et al., 1975; Houston & Simon, 1970).

2.4. Life insurance input proxies

One can identify a detailed list of life insurance inputs that includes items such as salaries, commission and related costs, underwriting, marketing, systems costs, administration of investments, client service, and general overhead (Carr, 2004). However, the majority of life insurance efficiency articles adopt a very narrow set of input proxies as compared to this list, a lack of precision which seems to decrease the validity of their results. Of the papers perused, only twenty-four percent use more than three input proxies which is deficient, as it seems best to endeavor to use as detailed list of inputs as is feasible.

2.5. Output and input prices

Another feature of previous life insurance efficiency papers is that for those specifying input prices over seventy-eight percent of the studies seen use some common input prices (by year) across companies. Of said studies more than forty-six percent only have input prices that are common (by year) across companies. For 2012-2016 research perused specifying input prices more than seventy-one (thirty-eight) percent use some (only) said common input prices.

This is a shortcoming because different insurers pay different prices for inputs such as wages, materials and capital. Let us consider equity capital as an example. The most recent LIC efficiency articles observed with (virtually) common (by year) capital prices use 1) the thirty-day Treasury Bill rate at the end of year plus the long-term average market risk premium on large company stocks plus the long-term average size premium from Ibbotson Associates (Grace et al., 2014; Xie et al., 2010; Cummins et al., 2010, Cummins & Xie, 2009), 2) the 2005 average one-year Treasury constant maturity rate plus the long-horizon equity risk premium from Ibbotson Associates (Chen et al., 2013; Pottier, 2011), 3) seven-year averages of yearly rates of return of the Swiss Market Index (Biener et al., 2014), 4) one-year rates of Malaysian Government Securities (Ismail et al., 2013), 5) a constant rate of 15.95% (15.44%) for Croatian (Slovenian) LICs (Medved & Kavcic, 2010) and 6) the one- year Treasury bill rate (Kasman & Turgutlu, 2009). Obviously, as LICs have different sets of assets they have different costs of capital so assuming they have a constant cost of capital is inaccurate.

Perhaps more egregious regards the price of labor. The most recent LIC efficiency articles observed with common (by year) labor prices use 1) the average salary in finance, insurance and real estate and business services sector available from the Ministry of Saudi Labor (Jedidia & Medhioub, 2015), 2) the per capita wage from the Wind Datafeed Service database (Liu, 2015), 3) the wage rate for the state where the home office is located (for administrative labor) (Grace et al., 2014), 4) the annual wage for the Swiss insurance sector from the Swiss Federal Statistical Office (Biener et al., 2014) and 5) the national "average weekly earnings of production workers" from the U.S. Department of Labor for direct life and health insurers and insurance agencies (for administrative and agent labor, respectively) (Chen et al., 2013; Pottier, 2011; Xie et al., 2010; Cummins et al., 2010, Cummins & Xie, 2009). LICs have even more different rosters of employees than sets of assets so assuming they have a constant cost of labor is definitely inaccurate.

Furthermore, some LIC efficiency articles have common output prices. Evidently, LIC efficiency studies using common prices are flawed as it appears best to employ input and output prices that differ by company, more closely reflecting reality.

There are several conclusions regarding the best methods and proxies to use to conduct LIC effi-

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ciency research reached from either this review or the discussion below. The first is that it is clear that the SFA is the best method to adopt for the measurement of LIC efficiency. Regarding output proxies and the question of which set 1) reserves and claims or 2) premiums and investment income is more suitable, the discussion below shows that neither reserves nor claims are a good output proxy and that the set of premiums and investment income is the best to use for LIC efficiency studies.

This review also relates how LIC efficiency studies do not use detailed lists of inputs which is a weakness and how the use of common input and output prices is a problem in that, in reality, said prices differ by company.

3. DISCUSSION

3.1. Output proxies: reserves and claims

To apply efficiency theory correctly to LICs in light of what they produce necessitates specifying the best output and input proxies. For outputs, as explained by Cummins and Weiss (2000), insurers are analogous to other firms in the financial sector of the economy in that their outputs consist primarily of services, many of which are intangible (Kim & Grace, 1995). So as Weiss (1986, p. 54) relates that "measurement of output volume is a difficult problem as services are not directly observable". Any efficiency score results obtained moreover can be "misleading or meaningless" if outputs and inputs are not defined properly (Cummins & Weiss, 2000; Jarraya & Bouri, 2013). Also "careful analysis is required to isolate measurable factors that are directly proportional to the services provided" (Weiss, 1986, p. 55).

Such an analysis leads to the conclusion that there are problems with utilizing reserves as an output proxy. For instance, Weiss (1986, p. 55) declares that not employing (change in) reserves as an output "assumes that society as a whole would experience the same losses [in the future] whether these were paid for by the pool of insurance premiums or borne solely by the victim of the loss". Accordingly as these future "loss payments are not produced or created by the insurer [they] should not be included in the value of output".

There are also specific drawbacks associated with including (change in) reserves as an output proxy. One example occurs when change in reserves is used as a proxy for new business such as is done in Cummins et al. (1996) and Yuengert (1993). Of the numerous hitches with this is that reserves increase for in force business. For a "plain vanilla" whole life policy (a risk product) for a thirty five year old male non-smoker, the reserves will increase from about $100 to about $110 on average per $1000 FV in force. Thus if at issue such a policy has a reserve of $100 an already in force amount of $100,000 will see an increase in reserves of about $1,000 and consequently the reserve increases for the in force will swamp those for new business[5].

Incorporating change in reserves as a proxy for other new business output is also problematic. Reserves decrease with age for annuities, hence, the amount of new business output is understated substantially when using reserves as a proxy. For investment-linked policies, the same concept applies as for risk products. Therefore, change in reserves is not a good proxy for new business amounts for either annuities or investment-linked products. So for any product type, change in reserves is not a good proxy for new business amounts.

Versus a proxy for new business output, change in reserves is applied as a proxy for intermediation in some efficiency research, but this presents further difficulties. Asset values or investment income are a better proxy for intermediation as the assets actually yield the output from intermediation. To try to justify specifying change in reserves as a proxy for intermediation, the authors use the idea that (algebraically) the retrospective reserves equal the prospective reserves for a product. However, this is only true if all of the assumptions applied to calculate the reserves are met. As in many jurisdictions these valuation assumptions are set at is-

5 The $100 is just after the first premium payment and this value is extremely high (as the reserve just after the first premium payment is more likely to be in the order of $10) just to make the point of the example. Additionally, there are artificial reserve methodologies cited below that present problems here.

sue, which may be years before the date of the data utilized, said equality is virtually impossible. As a result, the reserve does not equal the asset value and change in reserves is not a good proxy for intermediation.

Furthermore, there are basic conceptual and practical reasons why (change in) reserves is not a good proxy for anything other than themselves. Reserves represent the future (Greene & Segal, 2004) accordingly trying to draw upon them as a proxy for a current value seems intuitively questionable. As an example of a practical shortcoming, in the United States and Canada, for some products and/or jurisdictions the reserve at issue, and one (and possibly one-and-a-half or two) year(s) after issue are all set to zero artificially to help relieve the capital strain and expense of issuing policies. Consequently, trying to apply (change in) reserves as an output proxy seems dubious. Also different products have different reserve values and differing patterns of increases in them. Thus, employing the reserves of a life insurer lumped together as is done in several items including Cummins et al. (1996), Karim and Jhantasana (2005) and Biener et al. (2014) is problematic.

Using reserves as an output proxy additionally leads to the significant difficulty that valuation assumptions and methods vary greatly between insurers. This variation may be so great that the reserve values between insurers may mean or represent vastly different things. These variations may result in mitigation effects, e.g. a higher expense assumption would lead to less profit now, and a lower efficiency score, but concerning reserves, such mitigation effects are not always intuitive. For instance, the outcome of a higher mortality assumption will be not only higher premiums (and so act to lower reserves), but also higher claims (and so serve to increase reserves).

Another deficiency with incorporating reserves is that at least periodically, insurers change valuation methods or assumptions leading to reserve changes without any change in the value for which they are ostensibly a proxy. Similarly, at times, ad hoc increases are made to an insurer's reserves; again resulting in a false apparent change in the value for which they are supposedly a proxy.

Therefore, due to the reasons of 1) artificial reserve values, 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 and the other reasons elucidated above, it appears evident that the notion of any aspect of reserves being a good proxy for "real" services or future losses to be paid to policyholders is dubious at best. Moreover, reserves are not a good proxy for either new business or intermediation output as seen above. The conclusion reached is that for all of the aforementioned reasons, it seems unambiguous that reserves are not a good proxy for anything other than themselves.

There are also flaws in employing claims as an output proxy including that they are not a good proxy for funds pooled, as these are better represented by premiums, because it is the premiums that are used to purchase the assets backing the liabilities. In addition, claims represent FV and it is described below how premiums is a better output proxy to draw upon than is FV. Also different products with the same FV generate different premiums which then results in different amounts of funds to be pooled thus specifying claims is not as accurate indicator of pooled funds as is premiums.

The object of risk-pooling being to pay claims seems questionable. Other more probable objectives from the viewpoint of insurers and their investors seem to be profits, goodwill and diversification (Rao, et al., 2010). Also policyholders and regulators desire profit and they probably consider safety to be more important. Furthermore, because reserves is such a bad proxy for everything, combining claims with them to proxy anything seems dubious.

Another important point is that most "real services" performed by insurers are not highly correlated with claim amounts. Examples abound such as 1) policy administration as only continuing policies are administered, 2) underwriting as this is associated with new business and not claims, 3) investment management as only continuing policies have assets backing their liabilities, 4) advertising, marketing, sales and similar activities that are linked only with the acquisition of new business and 5) a plethora of other activities of LICs

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that can be designated as "real services" such as upper-level management, actuarial, systems, accounting, legal and reinsurance-linked activities which are all mostly executed only with respect to in force policies. So claims do not to represent "real service" output of LICs in any manner. For the same reasons, claims do not represent current expenses; they measure past activity.

As claims represent the end of the policy, the outcome is a loss of future profits and probably negative profits now. Diacon et al. (2002) refer to Cooper, Seiford, and Tone (2007) in citing that using claims as an output proxy leads to the counter-intuitive idea of an insurer desiring less output as a problem, as it goes against the belief of the object of risk pooling is being paying losses.

There are also fundamental numerical deficiencies with applying (change in) reserves or claims as an output proxy. Most reserving methods have a $1,000 whole life policy issued to a thirty-five year old having the initial reserve as about ten dollars climbing to about 950 dollars near age 117, averaging about $11.50 per year. Moreover, the reserve increase is not constant per year, another flaw. Incorporating reserve change as an output proxy gives that value of measured output per year. If the policyholder claims when the reserve is $500 the output is measured as -$500, clearly nonsensical. If the claim is when the reserve is $300, the output is measured as -$300, a vastly different amount from the previous case, even though the company activity is identical, so in this sense also nonsensical. If the article utilizes the reserves themselves as an output proxy, the same annual activity of the life insurer becomes measured as an ever-increasing amount, again is nonsensical.

If the output proxy specified is claims plus reserve change (as done in some research), then upon claim this output proxy becomes $500 ($700) if the reserve is $500 ($300). In each case, the only additional company activity is claims administration, obviously not commensurate compared to the $11.50 per year measured output before the claim. If claims only is the output proxy, then the measured output is zero for all years until claim and then $1000 in claim year, even more problematic than when using reserves.

In contrast to the whole life case, for instance, with a twenty year term policy, the reserves increase to about $18 in (at least) ten years which gives (at most) $1.80 per year as the output, about 15.5% that of the whole life policy. Clearly, this is not correct, as the activity of a company is not very different between the two types of policies. Hence, when comparing different policy types, it is further apparent that reserves is not a good output proxy.

Another practical difficulty with drawing upon claims and/or reserve (change) as output proxies occurs when using the nonparametric data envelop analysis (DEA) as the efficiency measurement method. DEA assumes that outputs are isotonic, i.e. desirable (Dyson et al., 2001). However, here this is not true with one of the solutions suggested by Dyson et al. (2001) being having such an undesirable output be an input. Sinha (2015) augments the concept by concluding that utilizing undesirable outputs will probably give incorrect results, because such outputs should be decreased, while desirable outputs should be increased.

Finally, Geehan (1977) agrees with the opinion of Doherty (1981) that premiums do not accurately represent LIC output as larger LICs have a higher ratio of permanent to term insurance. The paper explains that Belth (1966) has shown this ratio disparity plus that price is negatively correlated with firm size, however, when perusing data from the United States and Canada, it is evident that there is no such correlation (National Association of Insurance Commissioners, 2015; OSFI, 2015).

Similar to reserves, then, for the reasons revealed prior of 1) the object of risk-pooling (via insurance) to pay claims being questionable, 2) most "real services" performed by insurers not being correlated with claim amounts, 3) claims possibly increasing (rapidly) which makes the insurer falsely appear more productive, 4) claims representing past activity much more than present activity of the insurer, 5) a claim leading to a loss of future profits and the other aforesaid reasons the conclusion reached is that it seems evident that claims are not a good proxy for output.

3.2. Output proxies: premiums and investment income

With respect to FV as mentioned in sections 2.3 and 3.1, premiums seem to be a better proxy for output than either FV or policy count as demonstrated by starting with the fact that there are different premiums 1) per FV for different products and 2) per policy for the same product (the latter as different policies have different sums insured (SIs)). Considering the three possible cases illustrates 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. A policy generating $100 premium gives more output than a policy generating $50 premium as the former generates more profit. Therefore, the $100 policy is more desirable and the two policies are not considered the same. The different premiums might be due to different SIs or due to different products. For instance, a whole life policy premium is higher than a term policy premium per FV amount and the former's profits are ostensibly higher. Moreover, it is usually the case that riders do not add to either FV or policy count in force yet they do create additional premium and thus more profit. In the first case, premiums is a better proxy for output than either FV or policy count.

The second case concerns the same firm at different times; a situation not necessarily totally straightforward. A past policy yielding $50 in premium may lead to more profit for the firm than a current policy yielding $70 in premium, perhaps due to expense or mortality differences. Consequently, the former gives greater output. The same problem exists when employing either FV or policy count as a proxy, e.g. less FV written previously might be seen as more output in the same way for the same reasons. Also premiums involve mitigation effects, for example, higher expenses give rise to not only less profit now, but also a lower efficiency score; mitigation effects that may not be as obvious if using FV or policy count as a proxy. In this case, premiums are as least as good a proxy for output as is either FV or policy count.

For the third case, comparing different companies, the second case explanation applies. Taking the three cases into account, premiums is a better proxy for output than either FV or policy count. Several authors agree with such a conclusion. Hammond et al. (1971, p. 182) remark that premiums are a more useful proxy than is either FV or policy count as "a firm with three times the premium volume of another is, in a sense, producing about three times as much insurance protection" and Pritchett (1973, p. 160, fn. 8) writing that FV is "highly correlated with the volume of premium income" (anyway). Furthermore, some researchers convey that policy count may be flawed as an output proxy due to a heterogeneity of insurance policy contracts (Hammond, 1971; O'Brien, 1991) including dissimilar needed requirements for several reasons (Cummins, 1977).

As to the abovementioned debate in the literature between applying 1) premiums and investment income versus 2) reserves and claims; drawing on premiums as an output proxy can involve mitigation effects, because different companies use different methods and assumptions for calculating premiums, but between companies these differences are much closer for premiums than they are for reserves. Additionally, the mitigation effects are more intuitive regarding premiums. Therefore, when examining such mitigation effects, premiums seem a better output proxy than do reserves.

Regarding investment income, several studies, for instance, Atiquzzafar and Uzma (2014) and Berger, Cummins, Weiss and Zi (2000) use asset values, not investment income, as an output proxy. However LICs generate investment income as an output from their asset investments. Hence, to proxy output, it is better to incorporate a flow value rather than a static value because the former gives a better idea of current ability and activity. So the best output proxy here is the actual investment income earned being the outcome of managing the funds received. Another difficulty with specifying asset values as a proxy for investment income is that asset values can fluctuate leading to an apparent change in output when no change actually occurs. The conclusion is that it is better to utilize investment income rather than asset values as a proxy for life insurer output.

An important element when investigating output proxies is the timing issue. Due to the nature of life insurance any value drawn upon as any proxy results in a timing issue, hence, it must be minimized. If using claims or reserves as an output proxy, the timing issue presents a greater shortcoming than if

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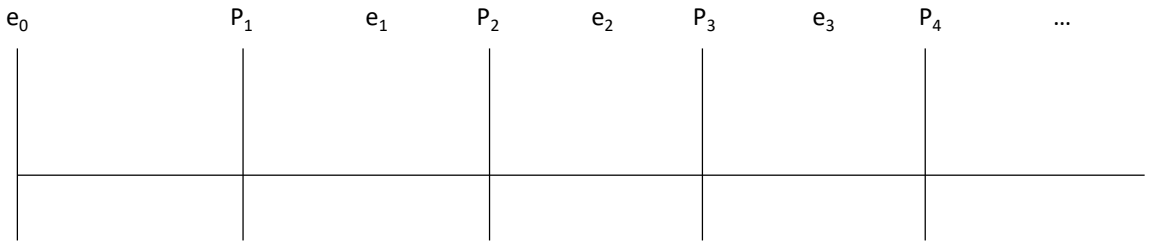

Figure 1. Timeline relating premiums (as outputs) to expenses (as inputs) for life insurers

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. To show that premiums is more appropriate with respect to timing begin with the definition of Weiss (1986, p. 54) as output being the "marketable result of the production process". Consider the following two cases.

The first case is periodic premiums where the majority is designed to pay for present needs; the future piece representing items such as future expenses, dividends and surrender values. The definition from Weiss (1986) of inputs being transposed into outputs is displayed in the timeline of Figure 1 below. Figure 1 depicts the production process (original sales and marketing) of the company, e_0, generating the first premium, P_1, as the original output which pays for e_1, the production process (expenses incurred in/other inputs) of the first period, which helps manufacture the second premium, P_2, which pays for e_2, etc.

Thus, applying the Weiss (1986) definition, for this case, given the timing issue along with the prior discussion periodic premiums are obviously a better proxy for output than either claims or reserves.

The other case regarding premiums is single premiums. For single premium policies such as annuities; commissions, sales effort, advertising, advice, underwriting and policy set-up are all at issue. Moreover so are capital and reserve requirements. After issue the relevant components are administration, investment and claims payment expenses. Consequently, it is clear that the majority of the input is at issue, and this means that even single premiums are geared to the present. Again considering both the timing issue and the above discussion it is evident that premiums are a better proxy for output than are either reserves or claims.

Finally, premiums being input transposed into output is a perception used in some studies analyzing financial institutions. The earliest occurrence observed in the literature is in Sealey and Lindley (1977). However, as stated in the preceding, for life insurance; commissions, sales effort, advertising, advice, underwriting, policy set-up, etc., can be seen to be input being transposed into both the initial and subsequent premiums as output. Thinking of the process in the reverse direction implies that a policyholder pays premiums so that the company's employees will have tasks to perform and so continue to be employed; clearly nonsensical. Additionally the policyholder must believe that the company's functions are all operating properly or else they will not continue to pay premiums.

3.3. Best output proxies to use to measure LIC efficiency

For all of the aforementioned reasons of 1) both reserves and claims are inappropriate output proxies, 2) both reserves and claims have numerical problems, 3) premiums and/or related measures have been used as an output proxy from the earliest literature regarding cost and efficiency, 4) premiums are a better output proxy than is FV or policy count, 5) mitigation effects are closer and also more intuitive for premiums than for reserves, 6) there are fundamental numerical problems when incorporating reserves or claims as an output proxy, 7) DEA is not geared to drawing upon reserves or claims as an output proxy, 8) the timing issue is less of an issue for premiums and 9) premiums matches better to the concept of having inputs transposed into outputs the first of the two most prevalent sets seen above, premiums and investment income, is the best to use for life insurance efficiency studies.

CONCLUSION

This paper has demonstrated how, when measuring LIC efficiency, it is imperative to use the proper method and the proper output/input proxies. Concerning methods, because DEA, TFA and DFA are inappropriate as explained in section 2, chiefly because there is no accounting for random error, but moreover, for example, a susceptibility to being influenced by the number of parameters and firms; one should utilize SFA.

Due to the aforementioned reasons, it is clear that premiums and investment income are the best output proxies. For premiums, the chief reasons are as listed as 1) through 9) in section 3.3 and for investment income the main reasons are that it 1) is a flow value and 2) gives insight into the investment ability of life insurers. Sections 2.4 and 2.5 show why specifying a detailed list of inputs and input/output prices that are not common is ideal.

As it is essential for a nation's economy that LICs be healthy and viable, when evaluating them it is critical to do so properly. Not doing so can bring consequences up to and including LIC bankruptcy. Such an occurrence can be detrimental to a nation's financial services and other industries, households and a nation's economy in general. The outcome can also be a lack of confidence in the financial services industry, as well as the insurance industry and potentially result in a reduction of insurance protection for business and the overall public. Therefore, to avoid such problems/consequences, it is necessary to evaluate life insurers correctly and to do so hopefully this paper will be useful.

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