# Analysis of Cost Efficiency of Indian Life Insurers

## 1 Introduction

The objective of this paper is to analyse trends in the cost efficiency for the Indian insurance industry. The Indian insurance industry was liberalized in the year 1999. The IRDAI[1] (Insurance Regulatory and Development Authority of India) was established as the regulator and supervisor for the industry to facilitate development of the industry, promote and secure competitive market outcomes. The market was re-opened for private insurers in August, 2000 through notification inviting application for registration. Life Insurance Corporation of India (LICI), formed in 1956 following nationalisation, operated as a natural monopolist till 23rd October, 2000[2]. Over a period of three and a half decades (1957 to 1993-94), LICI's activities grew as a result of increased share of rural insurance and group insurance business in total insurance business accompanied by the spillover economic effects of urbanisation especially during the eighties. As pointed out by [Bhattacharya and Pal, 1996] that economies of scale existed in the life insurance industry, LICI's social orientation[3] forced operational costs to remain at higher levels [Rao, 1998]. LICI's operating economies decreased as it expanded its activities [Bhattacharya and Pal, 1996, Rao, 1998, Tone and Sahoo, 2005]. Liberalization may have led to significant improvements in cost efficiency of

[1] Formerly known as IRDA

[2] Date when the initial batch of new registrations were granted. However, the insurer to start business in December, 2000 were HDFC Standard Life Insurance Company Limited and ICICI Prudential Life Insurance Company Limited

[3] The item *profit* is not mentioned in the Annual Reports of the Corporation prior to its 45th Annual Report

LICI [Tone and Sahoo, 2005]. Therefore, it is of interest to analyse cost efficiency of LICI and of the private life insurers post liberalisation. To the best of author's knowledge, there is no study on this issue which is essential for drawing policy road map for future development of the industry.

There are currently 24 life insurers in the country of which one is public (LICI) and 23 are private life insurance companies. The private life insurers are categorised as those partially promoted by foreign insurers and those promoted by a business entity of Indian origin(three in number). Foreign ownership was restricted to 26% and recently enhanced to 49%)[4]. Data from SwissRe [2016] reveal that post liberalization, total premium collection increased from $6406 million in 1999 to $71776 million in 2015[5]. Life insurance premiums accounted for 79% of total premiums in 2015. As a result, life insurance penetration improved from 1.45% to 2.72% of GDP and life insurance premiums per–capita rose from $6.3 to $43.2 over the period 1999-2015. The total benefits paid (net of re-insurance) went up from Rupees 174.79 billion in 2001-02 to Rupees 2109.15 billion in 2014-15. There have been problems of the delays in claim settlement, policy lapses and surrenders, which may have hurt the growth of the market.

The major impediment towards growth of the Indian insurance industry in general and the life insurance industry in particular were reported to be rising operational costs[6]. The insurers were expected to innovate and leverage on technology to minimise costs, improve profitability and comply with regulations prioritising protection of policyholders' interests[7]. Although there was rush of foreign insurers when the insurance market was re-opened but in recent years, global insurers have either withdrawn or are preparing to exit Indian market. This is because of cost competitiveness and constraints in their domestic markets. In this study, we compare two non-parametric

[4]Consolidated FDI Policy Circular 2014, effective April 17 2014 (http://dipp.nic.in/English/acts_rules/Press_Notes/pn3_2015.pdf)

[5]SwissRe [2015] reports the data on Indian insurance industry for the financial year 1 April 2015 to 31 March 2016

[6]Reports market analyses by Ernst & Young (2012) and KPMG (2013). Reports are available at http://www.ey.com/Publication/vwLUAssets/Insurance_industry_-_challenges_reforms_and_realignment/$FILE/EY-Insurance-industry-challenges-reforms-realignment.pdf and http://www.kpmg.com/IN/en/IssuesAndInsights/ArticlesPublications/Documents/Insurance_industry_Road_ahead_FINAL.pdf

[7]Refer Deloitte [2011]. Available at: http://www.deloitte.com/assets/Dcom-India/Local%20Assets/Documents/Indian%20Insurance%20Sector.pdf

(Data Envelopment Analysis, DEA) cost efficiency models. The traditional Farrell-Debreu model and the correction proposed by Tone [2002] were estimated to analyse cost inefficiency of the life insurers in India for the period 2005-06 to 2015-16.

Data Envelopment Analysis (DEA) has been widely used to analyse performance of insurers[8]. It is a linear programming approached to construct a nonparametric production frontier using methods introduced in Charnes et al. [1978], and described in Charnes and Cooper [1985], Grosskopf [1986] and Fried et al. [2008]. Recent applications of DEA to analyse performance of the Indian insurance industry include studies by Sinha [2006, 2007], Chatterjee and Sinha [2009], Sen [2010], Sinha [2010], Dutta and Sengupta [2011], Chakraborty et al. [2013] and Sinha [2015]. Above studies used the simple DEA models proposed by Charnes et al. [1978] and Banker et al. [1984] to evaluate technical, pure technical and scale efficiencies. Few studies also calculated the Malmquist productivity indices using balanced panel data and considered smaller sample size. The purposive exclusion of new insurers may not fully help assessment of relative technical efficiency. Moreover, the results may be misleading or biased in favor of insurers operational for large number of years under observation. For example, almost in all studies LICI was reported to be the most efficient insurer. Because of its market share, large volumes of insurance reserves and investments, it is discerned to be the best performing life insurer. But, LICI's large agency force, wide network of branches and related management costs, larger expected claims, delays in claims settlement, policyholder grievances, among other issues, could be detrimental to its overall performance. Therefore, it is reasonable to expect that private insurers may compete with the dominance of LICI and exploit economies of scope through adoption of technology and international best practices in insurance provisioning. Except [Tone and Sahoo, 2005][9], no study have so far used unit price and unit cost information to calculate cost, allocative and technical efficiencies. Data limitation may render such efficiency evaluation difficult but to assess overall efficiency, it is important to calculate cost efficiency.

This study innovates in this context and presents results considering in-

[8]Eling and Luhnen [2010] and Cummins et al. [2010] provide comprehensive review of such studies.

[9]Tone and Sahoo [2005] analysed performance of LIC over the period 1994-95 to 2000-01. They presented a new alternative nonparametric approach towards measurement of scale elasticities, but considered only one decision making unit (DMU).

formation on prices and costs. According to Cooper et al. [2007], technology and costs are the wheels driving the new age organisations and information on how and to what extent cost minimisation is possible may help management to reduce losses due to technical, price and allocative inefficiencies. Using price information, economic measures of efficiency can be decomposed further into technical and allocative efficiencies. This study demonstrates how cost efficiency varies with insurance provisioning and how actual costs departs from efficient (optimal) cost. The study further uses the cost efficiency estimates to examine their relationship with selected non-discretionary variables (level of competition, market structure, solvency ratio and presence of foreign insurers). The underlying hypothesis is that post liberalization, public as well as private life insurers were cost efficient. It is also assumed that the selected non-discretionary variables does determine cost efficiency of the life insurers.

The remainder of this paper is organized as follows. Section 2 presents a brief overview of the life insurance industry. Section 3 outlines the rationale for input-output selection and the rational behind selecting the non-discretionary variables. In Section 4, the empirical findings and policy implications are discussed. The final section concludes with the key observations from the study.

## 2 Life Insurance Industry: India

The Indian life insurance business dates back to 1818 and the Insurance Act of 1938 (hereafter IA1938), a comprehensive legal document, guided the industry in the pre-independence British era. Post independence, incidents of fraud and bankruptcy of insurance companies paved the path towards nationalization and complete government control of life insurance business in 1956. Direct public ownership and control was initiated with the implementation of LIC (Nationalisation) Act, 1956, following which 154 operational life insurers were merged to form the Life Insurance Corporation of India (LICI). Financial sector reforms and requirements under the General Agreement on Trade in Services (GATS) demanded deregulation and liberalisation of the insurance industry. The Malhotra Committee made a strong case in 1994 for activating professional regulation as a matter of priority, almost as a condition precedent to the opening up of the insurance industry to private participants [Pant, 2000]. Liberalisation was predicted to promote greater efficiency and innovation, thus fostering the development of the insurance market [Ranade and Ahuja, 2000]. However, in contrast to the regulation of the banking industry, the insurance industry lacked a well-developed regulatory system and IA1938 needed massive overhauling. In 1999, Insurance Regulatory and Development Authority (IRDA) replaced the Controller of Insurance (COI) and insurance industry liberalized, thereby opening it to private and foreign operators [Palande et al., 2003].

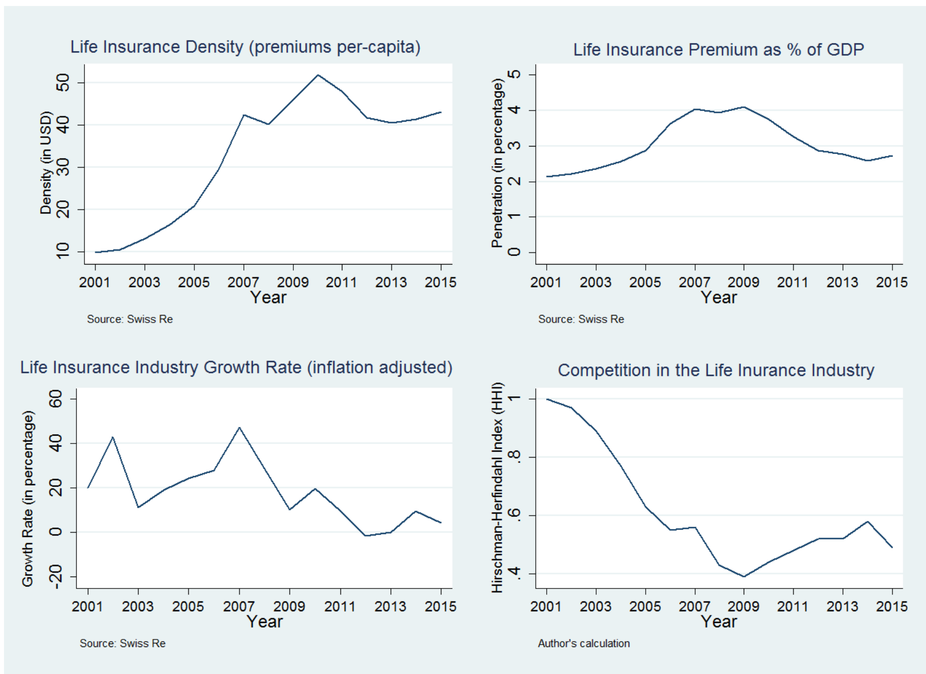


Figure 1: Life Insurance: Key Statistics

A snapshot of the life insurance industry using four key statistics is presented in Figure 1. The life insurance density and penetration data from SwissRe show a rise after liberalisation but after 2009, both the indicators exhibit a downward trend. The share of Indian insurance business in global insurance industry has increased from 0.5% in 2001 to around 2.24% in 2015. However, growth has slowed. In terms of market concentration, LIC continues to dominate with (73%) market share. In 2009-10, for the first time after liberalization, new policies sold by private insurers witnessed a decline of -4.32% primarily due to changes in sale of Unit Linked Insurance Policies (ULIP). Policy sales have been declining during the last two financial years.

A slow growth rate of new policies in 2011-12 (of -4.52%) was mostly due to poor performance of LICI. The first year life insurance premium volume increased from INR 97 billions in 2000-01 to INR 1389 billion in 2015-16. During this period, the total insurance premiums collected by insurers rose from INR 349 billion to INR 3669 billion.

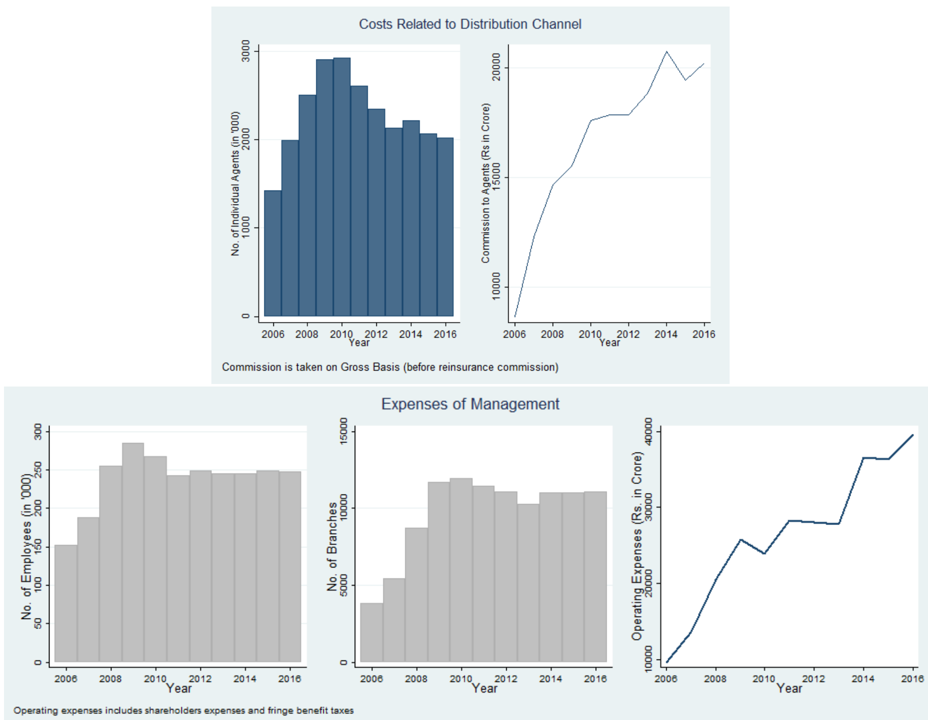


Figure 2: Expenses by Insurers

The increase in premium volumes was due to increase in the number of insurer in the life segment of the industry and the strategies adopted by the insurers to exploit economies of scope. According to the Life Insurance Council of India, the number of branches have increased from 3816 in 2005-06 to 11071 in 2015-16[10]. The number of individual agents recruited by the life insurers have also gone up with LICI having the largest share (around 80 percent). The insurance industry directly employed 0.25 million in 2015-16 compared to 0.15 million in 2004-05. Furthermore, the insurers have intensified the use of electronic medium to expand the business. As shown in

[10]Data from IRDA Annual Report 2015-16

figure-2, these expansionary strategies have increased the direct costs related to the insurance business. In particular, there is rise in the commissions paid to the agents and the operating expenses. Insurance industry being highly capital intensive (with more stringent solvency regulation requirements), the cost of capital also increased in a relatively high interest rate regime. The impact of cost are expected to be different for the public sector insurer and the private insurers. This motivates analysis of cost efficiency and identification of firm specific factors explaining efficiency trends.

# 3 Technical, Cost and Allocative Efficiencies

Farrell [1957] developed the non-parametric frontier approach for estimating efficiency. The approach received attention following contributions by Charnes et al. [1978], Charnes et al. [1981] and Fare et al. [1985]. The linear programming approach comparing the efficiency of decision making units (DMUs) is referred to as data envelopment analysis (DEA). There have been large number of papers extending the approach[11] and also application of the methodology[12]. Charnes et al. [1978] proposed a model for evaluating technical efficiency which had an input orientation[13] under the assumption of constant returns to scale.

Consider a life insurance industry with **n** insurers, each using **m** inputs $x_{ij} = (x_{1j}, x_{2j}, ..., x_{mj})^T$ to produce **s** outputs $y_{rj} = (y_{1j}, y_{2j}, ..., y_{sj})^T$. Assume further that there is a non-negative scalar $\lambda_{\mathbf{j}}$ such that $\sum \mathbf{x}_{ij}\lambda_j$ and $\sum \mathbf{y}_{sj}\lambda_j$ are also possible inputs and outputs for an insurer. Referred to as assumptions of convexity and inefficiency, they imply that the output(s) $\mathbf{y}$ could be produced using more input(s) and the input(s) $\mathbf{x}$ may been inefficiently utilised to produce less output(s). Given these assumptions, the production technology is written as:

$$P = \{(\mathbf{y}, \mathbf{x}) \mid \mathbf{x} \geq \lambda\mathbf{x}, \mathbf{y} \leq \lambda\mathbf{y}, \lambda \geq 0\} \quad (1)$$

The technical efficiency $\theta^*$ of a life insurer $LI_o$ is obtained from the optimal

[11] Comprehensive reviews are available in Cooper et al. [2007], Ray [2004], Fried et al. [2008] and Coelli et al. [2005]

[12] [Cook and Seiford, 2009, Emrouznejad et al., 2008]

[13] All inputs are minimised at the same rate to the extent possible without reducing any output

solution of the following linear programming problem:

$$\min \theta \tag{2}$$

$$\text{subject to} \quad \theta \mathbf{x_{io}} \geq \sum_{j=1}^{n} \mathbf{x_{ij}} \lambda_j \qquad i = 1, 2 \ldots m$$

$$\mathbf{y_{ro}} \leq \sum_{j=1}^{n} \mathbf{y_{rj}} \lambda_j \qquad r = 1, 2, \ldots s$$

$$\lambda_j \geq 0 \qquad j = 1, 2, \ldots n$$

$LI_o$ is technically efficient if the optimal solution $(\theta^*, \lambda^*)$ yields $\theta^* = 1$, $\lambda_o = 1$[14]. $\theta^*$ is also known as radial efficiency [Fare et al., 1994].

Farrell [1957] also introduced the concepts of cost (*overall*) and allocative efficiencies, later developed by Fare et al. [1985]. Assume input prices are available, $\mathbf{w_{ij}} = (\mathbf{w_{1j}}, \mathbf{w_{2j}}, \ldots, \mathbf{w_{mj}})^{\mathbf{T}}, \mathbf{w} \geq 0$; for $m$ inputs used by $j$ insurers. For simplicity, we assume that $LI_o$ uses single input. Given information on input prices, the objective of the insurer is to minimize total input costs. The cost efficiency $\gamma^*$ is defined as:

$$\gamma^* = w_o x_o^* / w_o x_o \tag{3}$$

(3) is the ratio between minimum cost to observed cost for an insurer and if they are identical, the insurer is cost efficient. $x_o^*$ can be obtained from the following DEA model:

$$\min \sum_{i=1}^{m} \mathbf{w_{io}} \mathbf{x_{io}} \tag{4}$$

$$\text{subject to} \quad \mathbf{x_{io}} \geq \sum_{j=1}^{n} \mathbf{x_{ij}} \lambda_j \qquad i = 1, 2 \ldots m$$

$$\mathbf{y_{ro}} \leq \sum_{j=1}^{n} \mathbf{y_{rj}} \lambda_j \qquad r = 1, 2, \ldots s$$

$$\lambda_j \geq 0, \mathbf{x_{io}} \geq 0 \qquad j = 1, 2, \ldots n$$

[14]Banker et al. [1984] extended (2) and considered the constraint $\sum \lambda_j = 1$, providing for variable returns to scale. The efficiency estimate obtained is referred to as pure technical efficiency

The cost efficiency measures the factor by which the cost can be scaled down if the insurer operates with the optimal input bundle and also does not waste inputs [Ray, 2004]. The allocative efficiency $\alpha^*$ of $LI_o$ is referred to as the ratio of cost efficiency $\gamma^*$ to technical efficiency $\theta^*$:

$$\alpha^* = \frac{\gamma^*}{\theta^*} \tag{5}$$

(5) also suggests that cost efficiency is dependent on $(i)$ the least wastage of inputs $(\theta^*)$ and $(ii)$ most appropriate selection of input mix $(\alpha^*)$. It is important to note that Farrell originally defined $\theta^*$ in terms of input and output quantities rather than value[15]. However, various factors may restrict availability of quantity data[16]. In a situation where all the insurance companies are assumed to face the same set of input prices, technical efficiency calculated through value-based DEA model coincides with the quatitiy-based DEA models (Fare and Grosskopf [1985] and Cross and Fare [2008]). However, input prices vary across insurers and therefore value-based measures may not coincide with the quantity based measure of cost efficiency. Tone [2002] using a value-based DEA cost model shows that Farrell measure of cost efficiency has an undesirable characteristics and may declare a cost inefficient insurer as being cost efficient (Fukuyama and Weber [2004], Tone and Sahoo [2005] and Fare and Grosskopf [2006]).

Suppose $A$ and $B$ are two life insurance companies using the same amounts of inputs $(x_A = x_B)$ and producing the same amounts of outputs $(y_A = y_B)$. The unit cost of A is twice that of B, $c_A = 2c_B$. Although A and B are operating under different cost conditions, their cost and allocative efficiencies are same. The reason lies in the fact that the production possibility set, (1), does not include any price information. Tone [2002] proposed a cost-based production possibility set:

$$P_c = \{(\mathbf{y}, \bar{\mathbf{x}}) \mid \bar{\mathbf{x}} \geq \lambda\bar{\mathbf{x}}, \mathbf{y} \leq \lambda\mathbf{y}, \lambda \geq 0\} \tag{6}$$

where, $\bar{X} = (\bar{x_1}, \bar{x_2}, \ldots, \bar{x_n})$, with $\bar{x_j} = (w_{ij}x_{ij}, \ldots, w_{mj}x_{mj})^T$. $X$ is assumed to be non-negative and all inputs are associated with costs. A new

[15]For example, information on labour expenditure (value) is available rather than number of labour hours employed (quantity), payments made towards policy claims and maturity (value) available and limited or no information on number of policies (quantity) processed for claims settlement, etc.

[16]Such as regulatory requirement and difficulties in determining quantity measures of certain inputs and outputs, for example capital [Cross and Fare, 2008]

technical efficiency $\bar{\theta}^*$ is estimated from the linear programming problem:

$$\min \bar{\theta}^* = \bar{\theta} \tag{7}$$

$$\begin{aligned} \text{subject to} \quad & \bar{\theta}\bar{\mathbf{x}}_{\mathbf{o}} \geq \bar{X}\lambda \\ & \mathbf{y}_{\mathbf{ro}} \leq Y\lambda \\ & \lambda \geq 0 \end{aligned}$$

The new cost efficiency $\bar{\gamma}^*$ is defined as

$$\bar{\gamma}^* = e\bar{x}_o^*/e\bar{x}_o \tag{8}$$

where, $e \in R^n$ is a row vector with each elements being equal to one and $\bar{x}_o^*$ is the optimal solution of the following linear programming problem:

$$\min e\bar{x} \tag{9}$$

$$\begin{aligned} \text{subject to} \quad & \bar{x} \geq \bar{X}\lambda \\ & \mathbf{y}_{\mathbf{o}} \leq Y\lambda \\ & \lambda \geq 0 \end{aligned}$$

The new allocative efficiency is now defined as $\bar{\alpha}^*$:

$$\bar{\alpha}^* = \frac{\bar{\gamma}^*}{\bar{\theta}^*} \tag{10}$$

The Farrell measure and the Tone measure of cost efficiency are different in several ways. First, the former fails to recognize the existence of cheaper input mix. Second, the optimal input mix can be obtained independent of the current unit cost of the DMU under analysis. Third, if two insurers, A and B, uses the same level inputs to produce the same level of outputs but cost of A is greater than that of B, then the Tome measure will highlight insurer A to be technical and cost inefficient in comparison to insurer B.

The new measure of technical efficiency $\bar{\theta}^*$ is estimated based on input and cost factors whereas $\theta^*$ was determined by only input factors. These two estimates can be used for suggesting improvements in efficiency. If for $LI_o$,

1. $\theta^*$ is low and $\bar{\theta}^*$ is high, there is need for input reduction

2. $\theta^*$ is high and $\bar{\theta}^*$ is low, there is a need for cost reduction

The new allocative efficiency $\bar{\alpha}^*$ is less than or equal to one given $\bar{\gamma}^*$ is not greater than $\bar{\theta}^*$. Lower values of $\bar{\alpha}^* \ll 1$ implies need to change the input mix. Considering the cost based production possibility set (6), Tone [2002] proposed the concept of *returns to cost* similar to that of returns to scale. Inclusion of an additional constraint on $\lambda$, $e\lambda = 1$ would enable the new cost model to extend it identify average productivity behaviour of life insurers under variable returns. In the next section, a discussion on data is presented followed by results obtained from application of the so far discussed efficiency models.

# 4 Data and Empirical Findings

## 4.1 *Selection of Inputs and Outputs for Life Insurers*

The study uses firm-level annual audited financial data published by the IRDAI. The study period is 2005-06 to 2015-16. The insurance regulator as well as the Life Insurance Council provide operational data for the life insurers. However, it is often difficult to ascertain the quality of information. For example, the Life Insurance Council provides information on the number of direct employees (in the entire industry). But, the same is not available from IRDAI. Moreover, the management information system (MIS) of the Council is not comparable with that of IRDAI information. In this context, since the information disclosure by the insurers is based on the rules and guidelines proposed by the Authority, this study utilises data from IRDAI.

In line with recent insurance efficiency studies[17], this study considers insurers as providers of risk transfer services, having three specific functions namely, risk pooling, risk management and financial inter-mediation. It is assumed that risk pooling function reduces the risk that insurers are exposed to (on behalf of the insured). Therefore, the expenses (or costs) related to risk pooling is supposed to be one of the important components of value addition in the industry. The study follows the discussion of Cummins et al. [2010] in this regard and considers an insurer to use financial assets, undertake branch-level activities, hire commissioned agents to generate premiums through sales of new policies and renewal of old policies. The insurer objec-

[17]Eling and Luhnen [2010] reported 87 studies related to efficiency and productivity analysis on the insurance markets in the US, UK, Canada, France, Italy, Spain, Germany, Japan, Taiwan, China, and other European economies.

tive is to indemnify the insured in the event of loss and pay for the maturity of life insurance policies.

Four outputs were initially identified for this study and they are: 1) net benefits paid (total claims incurred plus bonuses), 2) net premiums, 3) income from investments and 4) total investments[18]. In the final analysis, only the first two were considered. Chakraborty et al. [2013], for example, considered income from investments as an output but in this study do drop this variable. The life insurer specific income from investment figures are not readily available from any report and the estimates reported in various Annual Reports of IRDAI have been calculated based on the information in the Policyholder's Account. But, following this rule, when an attempt was made to estimate income from investment, we observe major deviations. This is reported in table below. In many cases, the income from investments turn out to be a negative number. Therefore, unless there is clarity in the methodology towards calculation of income from investments, the use of the variable may give misleading results. Similarly, Tone and Sahoo [2005], **?** and **?** used total investments (or invested assets) as an output. The reasons for its exclusion from this study are first, regulatory constraints are key determinants of insurers investment strategies. Second, there is very limited scope for managerial efficiency in investment management and that the insurers, except LICI, have very limited investment portfolios.

Following review of literature, four inputs were identified and are considered for the study. In the absence of data on number of employees, the study uses number of branch and the number of agents (individual and corporate) as two separate inputs representing labour and business services respectively[19]. The ratio of total deflated operating expenses (excluding commissions to agents) to total number of branches is considered as price for labour where as price for business services is arrived at by dividing total deflated commission to agents with total number of agents with the insurer (individual

[18]It is important to consider investment activities of insurers as a source output because their investments are subject to government regulation. In India, these regulations require that a minimum of 50% is invested in approved Government securities, and not less than 10% in infrastructure and specified social sectors. The remaining investible assets may be invested in equities, bonds and other money market instruments. These regulations enable the Indian Government to generate investible resources and in return, the Government used to guarantee losses of the public insurers.

[19]A recent trend is to aggregate labour and business services into one category, namely operating expenses which includes commissions to agents as assumed by Fenn et al. [2008], Ennsfellner et al. [2004], **?** among others

and corporate agents). The remaining two inputs are debt capital and equity capital as defined in Tone and Sahoo [2005]. The price of debt capital is 10 years yield of SGL[20] transactions collected from the Reserve Bank of India. The price of equity capital was calculated as 9 percent plus the rate of inflation. All the selected outputs and inputs are in monetary values and are expressed in 2001-02 monetary units, deflated by the Consumer Price Index (CPI) for the industrial workers. Negative values were truncated at zero[21]. The selection of number of inputs and outputs satisfy the condition that $N \geq 3(r + s)$ for all years except 2005-06 and 2006-07.

## 4.2 *Results & Discussion*[22]

The descriptive statistics of the inputs and outputs are presented in the table 1. There is a substantial variation in data because of LICI. For example, in the years 2005-06 and 2006-07, some of the new insurers did not report any claim payments. But, for LICI, the claims and bonus figures are much larger. Infact, LICI's cost structure is very different from its closest competitor. The inputs and outputs are described in Table 2. The efficiency estimates are reported in table 3 through table 8. The tables presents technical efficiency scores, new technical efficiency scores, cost efficiency scores, new cost efficiency scores and new allocative efficiency scores for the sample insurance companies. As reported by earlier studies, LICI is indeed the most efficient life insurance company. However, a closer look at the results reveal that in comparison to Farrell measure of cost efficiency, the value-based DEA-cost model clearly shows that except for years2005-06 to 2008-09, LICI in recent years remained cost inefficient. The insurance industry in general, and more so the new entrants are frequently reported to be cost inefficient. The new cost efficiency model clearly highlights the concerns raised by Cooper et al. [2007] that differences in unit costs often affect DMU efficiency. Furthermore, due consideration to unit costs helps us in identifying DMU's having higher cost structures. A comparison of cost efficiency scores for the public and private insurers based on the Farrell approach and Tone [2002] is presented below.

[20]Subsidiary General Ledger Account

[21]DEA models have been developed, capable of incorporating use of negative data and undesirable inputs (or outputs). See Zhu [2009] and Cooper et al. [2007].

[22]Based on first set of estimated results

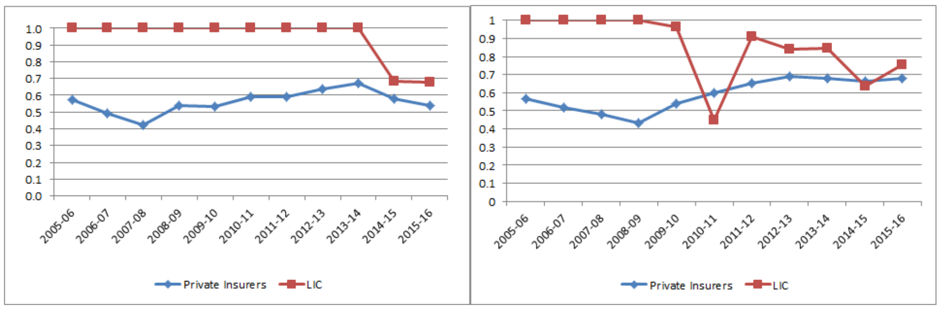


Figure 3: Life Insurance: Key Statistics

The performancne of LICI in terms of technical show that it is the benchmark insurer. Efficiency of LICI would suggest that, although it was established with a not-for profit objective, it did really use its given resources to reach the maximum level of output. The number of technically efficient life insurers may have increased during the study period but its seems economies of scope lies with LICI. However, considering the new cost efficiency model, we find that LICI was inefficient in recent years. An obvious question is to investigate the volume by which costs needs to be reduced or improved so as to reach the optimal level. The cost (overall) projections are given in figure 4.

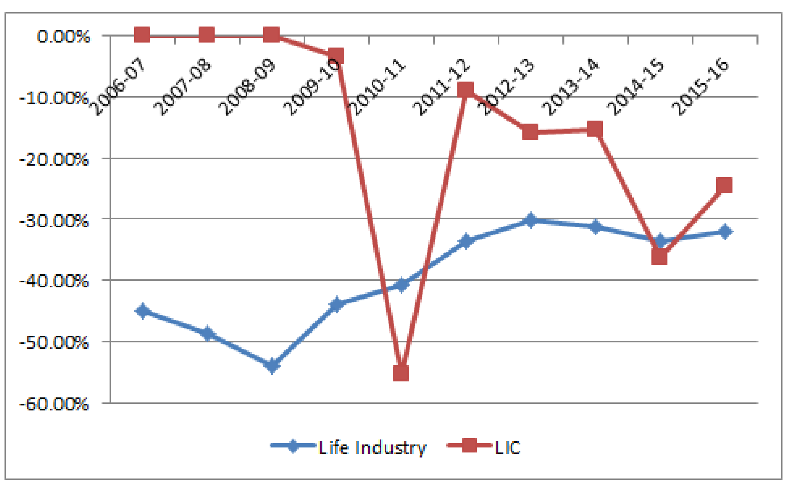


Figure 4: Life Insurance: Key Statistics

One of the reason behind cost inefficiency of LICI after 2008-09 may be high policy lapses and the unfavourable global financial crisis. In particular, for the year 2012-13, inefficiency may be attributed to the behaviour of the underwriting cycles. Inefficiencies were also due to scale factors and not entirely due to pure technical inefficiency. The above figure also indicate that the need for LICI to reduce costs is much higher than that of its competitors. In an effort to reduce the costs, the public insurer and the private insurers seems to be converging.

## List of Life Insurers

1. Bajaj Allianz Life Insurance Co. Ltd
2. Birla Sun Life Insurance Co. Ltd
3. HDFC Standard Life Insurance Co. Ltd
4. ICICI Prudential Life Insurance Co. Ltd
5. ING Vysya Life Insurance Company Ltd.
6. Life Insurance Corporation of India
7. Max Life Insurance Co. Ltd
8. PNB Metlife India Insurance Co. Ltd.
9. Kotak Mahindra Old Mutual Life Insurance Limited
10. SBI Life Insurance Co. Ltd
11. Tata AIA Life Insurance Co. Ltd
12. Reliance Life Insurance Co. Ltd
13. Aviva Life Insurance Company India Limited
14. Sahara India Life Insurance Co. Ltd.
15. Shriram Life Insurance Co. Ltd.
16. Bharti AXA Life Insurance Co. Ltd.
17. Future Generali India Life Insurance Co. Ltd
18. IDBI Federal Life Insurance Co. Ltd.
19. Canara HSBC Oriental Bank of Commerce Life Insurance Co. Ltd.
20. AEGON Religare Life Insurance Co. Ltd.
21. DLF Pramerica Life Insurance Co. Ltd.
22. Star Union Dai-chi Life Insurance Co. Ltd.
23. IndiaFirst Life Insurance Co. Ltd
24. Edelweiss Tokio Life Insurance Co. Ltd.

Table 1: Descriptive Statistics: *Inputs and Outputs*

| Code | Mean | Median | Standard Deviation | Range | Minimum | Maximum | Count |
|---|---|---|---|---|---|---|---|
| (I)x1 | 104035.67 | 29209.00 | 246769.28 | 1403315.00 | 2 | 1403317 | 236 |
| (C)x1 | 41.36 | 0.22 | 253.02 | 2495.31 | 0.03 | 2495.34 | 236 |
| (I)x2 | 458.08 | 180.50 | 785.89 | 4890.00 | 2 | 4892 | 236 |
| (C)x2 | 314.28 | 284.31 | 273.60 | 3386.57 | 24.43 | 3411.00 | 236 |
| (I)x3 | 3770961.66 | 366001.67 | 14325633.59 | 82766894.31 | 10483.45 | 82777377.76 | 236 |
| (C)x3 | 0.08 | 0.08 | 0.00 | 0.01 | 0.07 | 0.08 | 236 |
| (I)x4 | 87922.35 | 64392.47 | 79641.95 | 383105.47 | 8116.56 | 391222.03 | 236 |
| (C)x4 | 0.12 | 0.13 | 0.01 | 0.03 | 0.11 | 0.14 | 236 |
| (O)y1 | 307084.51 | 20069.15 | 1110106.03 | 6759305.17 | -15.34 | 6759289.83 | 236 |
| (O)y2 | 645611.59 | 93208.53 | 2144360.18 | 11409919.99 | 42.59 | 11409962.58 | 236 |
| (O)y3 | 3023955.03 | 217290.84 | 12108813.39 | 75815616.74 | 191.93 | 75815808.68 | 236 |
| (O)y4 | 981399.10 | 35702.29 | 3882562.99 | 43075007.63 | -891049.65 | 42183957.98 | 236 |

Table 2: Variable Description

| | | | |
|---|---|---|---|
| (I)x1 | No. of Agents | (I)x4 | Equity Capital |
| (C)x1 | Deflated Commission to Total no. of Agents | (C)x4 | 9% plus rate of inflation |
| (I)x2 | No. of Branch | (O)y1 | Benefits Paid |
| (C)x2 | Deflated Salaries & other benefits to Total no. of Branches | (O)y2 | Net Premiums |
| (I)x3 | Debt Capital | (O)y3 | Total Investments |
| (C)x3 | 10 years yield of SGL Transactions | (O)y4 | Investment Income |

Table 3: Comparison of Traditional Cost Efficiency and Tone(2002)-I

| | | 2005-06 | | | | | 2006-07 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **No.** | **Life Insurer** | **Tech** | **Ntech** | **Old Cost** | **Ncost** | **Nalloc** | **Tech** | **Ntech** | **Old Cost** | **Ncost** | **Nalloc** |
| 1 | A | 0.89 | 0.76 | 0.67 | 0.68 | 0.76 | 0.65 | 0.65 | 0.53 | 0.55 | 0.85 |
| 2 | B | 1 | 1 | 0.93 | 0.84 | 0.84 | 0.82 | 1 | 0.66 | 0.73 | 0.89 |
| 3 | C | 0.93 | 0.63 | 0.51 | 0.44 | 0.47 | 0.93 | 0.86 | 0.63 | 0.46 | 0.50 |
| 4 | D | 0.91 | 0.94 | 0.64 | 0.68 | 0.75 | 0.75 | 0.92 | 0.49 | 0.69 | 0.92 |
| 5 | E | 0.59 | 0.54 | 0.35 | 0.36 | 0.61 | 0.52 | 0.60 | 0.28 | 0.36 | 0.70 |
| 6 | F | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 7 | G | 0.38 | 1 | 0.25 | 0.37 | 0.97 | 0.73 | 0.87 | 0.38 | 0.43 | 0.58 |
| 8 | H | 1 | 1 | 0.92 | 1 | 1 | 1 | 1 | 0.56 | 0.72 | 0.72 |
| 9 | I | 1 | 1 | 1 | 0.83 | 0.83 | 1 | 1 | 1 | 1 | 1 |
| 10 | J | 0.92 | 0.83 | 0.69 | 0.70 | 0.77 | 1 | 1 | 0.66 | 0.67 | 0.67 |
| 11 | K | 0.99 | 0.66 | 0.59 | 0.53 | 0.53 | 0.84 | 0.77 | 0.67 | 0.54 | 0.64 |
| 12 | L | 0.56 | 0.49 | 0.28 | 0.27 | 0.48 | 0.57 | 0.54 | 0.39 | 0.31 | 0.54 |
| 13 | M | 0.81 | 0.59 | 0.40 | 0.43 | 0.53 | 0.77 | 0.75 | 0.45 | 0.42 | 0.55 |
| 14 | N | 0 | 0 | 0.26 | 0.23 | 0 | 0.28 | 0 | 0.15 | 0.29 | 1.03 |
| 15 | O | | | | | | 1 | 1 | 0.53 | 0.62 | 0.62 |
| 16 | P | | | | | | 0.06 | 0 | 0.02 | 0.02 | 0.33 |

Table 4: Comparison of Traditional Cost Efficiency and Tone(2002)-II

| | | 2007-08 | | | | | 2008-09 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **No.** | **Life Insurer** | **Tech** | **Ntech** | **Old Cost** | **Ncost** | **Nalloc** | **Tech** | **Ntech** | **Old Cost** | **Ncost** | **Nalloc** |
| 1 | A | 0.75 | 0.85 | 0.47 | 0.63 | 0.84 | 0.87 | 0.87 | 0.56 | 0.58 | 0.66 |
| 2 | B | 0.90 | 1 | 0.55 | 0.71 | 0.79 | 0.98 | 1 | 0.70 | 0.81 | 0.82 |
| 3 | C | 0.98 | 0.91 | 0.60 | 0.46 | 0.46 | 0.89 | 0.83 | 0.48 | 0.40 | 0.45 |
| 4 | D | 0.80 | 0.96 | 0.54 | 0.68 | 0.85 | 1 | 1 | 0.66 | 0.56 | 0.56 |
| 5 | E | 0.57 | 0.73 | 0.31 | 0.42 | 0.74 | 0.57 | 0.74 | 0.45 | 0.46 | 0.81 |
| 6 | F | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 7 | G | 0.85 | 0.99 | 0.35 | 0.49 | 0.58 | 0.83 | 0.79 | 0.42 | 0.41 | 0.49 |
| 8 | H | 1 | 1 | 0.57 | 0.65 | 0.65 | 1 | 1 | 0.78 | 0.75 | 0.75 |
| 9 | I | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 10 | J | 1 | 1 | 0.61 | 0.64 | 0.64 | 1 | 1 | 0.81 | 0.61 | 0.61 |
| 11 | K | 0.69 | 0.75 | 0.39 | 0.43 | 0.62 | 0.65 | 0.75 | 0.47 | 0.40 | 0.62 |
| 12 | L | 0.73 | 0.64 | 0.44 | 0.35 | 0.48 | 0.81 | 0.68 | 0.61 | 0.40 | 0.49 |
| 13 | M | 0.89 | 0.89 | 0.47 | 0.46 | 0.51 | 0.86 | 0.74 | 0.59 | 0.42 | 0.49 |
| 14 | N | 0.49 | 0.59 | 0.27 | 0.44 | 0.90 | 0.51 | 0.70 | 0.37 | 0.49 | 0.95 |
| 15 | O | 0.88 | 0.99 | 0.47 | 0.70 | 0.80 | 0.85 | 0.97 | 0.50 | 0.67 | 0.80 |
| 16 | P | 0.29 | 0.55 | 0.08 | 0.08 | 0.28 | 0.42 | 0.54 | 0.16 | 0.13 | 0.30 |
| 17 | Q | 0.00 | 0 | 0.01 | 0.01 | 0 | 0.27 | 0.41 | 0.13 | 0.10 | 0.38 |
| 18 | R | 0.00 | 0 | 0.09 | 0.07 | 0 | 0.72 | 0.94 | 0.55 | 0.37 | 0.52 |
| 19 | S | | | | | | 0.17 | 0 | 0.05 | 0.04 | 0.22 |
| 20 | T | | | | | | 1 | 0.50 | 1 | 0.25 | 0.25 |
| 21 | U | | | | | | 0 | 0 | 0.02 | 0.01 | 0 |
| 22 | V | | | | | | 0 | 0.03 | 1 | 0.23 | 0 |

Table 5: Comparison of Traditional Cost Efficiency and Tone(2002)-III

| | | 2009-10 | | | | | 2010-11 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **No.** | **Life Insurer** | **Tech** | **Ntech** | **Old Cost** | **Ncost** | **Nalloc** | **Tech** | **Ntech** | **Old Cost** | **Ncost** | **Nalloc** |
| 1 | A | 0.77 | 0.78 | 0.51 | 0.59 | 0.77 | 0.76 | 0.72 | 0.58 | 0.60 | 0.84 |
| 2 | B | 1 | 1 | 0.85 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 3 | C | 0.96 | 0.96 | 0.45 | 0.52 | 0.54 | 0.98 | 0.91 | 0.58 | 0.55 | 0.61 |
| 4 | D | 0.85 | 0.82 | 0.59 | 0.67 | 0.78 | 0.98 | 0.89 | 0.77 | 0.75 | 0.84 |
| 5 | E | 0.68 | 0.75 | 0.42 | 0.51 | 0.74 | 0.69 | 0.66 | 0.46 | 0.47 | 0.71 |
| 6 | F | 1 | 1 | 1 | 0.97 | 0.97 | 1 | 1 | 1 | 0.45 | 0.45 |
| 7 | G | 0.91 | 0.91 | 0.46 | 0.57 | 0.62 | 0.84 | 0.83 | 0.51 | 0.58 | 0.70 |
| 8 | H | 1 | 1 | 0.74 | 0.86 | 0.86 | 0.95 | 0.98 | 0.76 | 0.79 | 0.80 |
| 9 | I | 1 | 1 | 0.84 | 1 | 1 | 1 | 1 | 0.94 | 1 | 1 |
| 10 | J | 1 | 1 | 0.69 | 0.77 | 0.77 | 1 | 1 | 0.77 | 0.75 | 0.75 |
| 11 | K | 0.71 | 0.75 | 0.41 | 0.48 | 0.67 | 0.69 | 0.69 | 0.48 | 0.53 | 0.76 |
| 12 | L | 0.73 | 0.73 | 0.41 | 0.47 | 0.64 | 0.64 | 0.90 | 0.46 | 0.51 | 0.57 |
| 13 | M | 0.91 | 0.84 | 0.54 | 0.55 | 0.61 | 1 | 0.90 | 0.69 | 0.62 | 0.69 |
| 14 | N | 0.60 | 0.73 | 0.40 | 0.56 | 0.93 | 0.53 | 0.64 | 0.34 | 0.53 | 0.82 |
| 15 | O | 1 | 1 | 0.49 | 0.66 | 0.66 | 1 | 1 | 0.67 | 0.82 | 0.82 |
| 16 | P | 0.60 | 0.68 | 0.15 | 0.19 | 0.31 | 0.53 | 0.66 | 0.18 | 0.22 | 0.33 |
| 17 | Q | 0.87 | 0.87 | 0.20 | 0.21 | 0.24 | 0.72 | 0.72 | 0.21 | 0.28 | 0.39 |
| 18 | R | 0.80 | 0.85 | 0.43 | 0.51 | 0.64 | 0.67 | 0.67 | 0.38 | 0.49 | 0.73 |
| 19 | S | 0.43 | 0.65 | 0.10 | 0.11 | 0.26 | 0.53 | 0.59 | 0.13 | 0.17 | 0.29 |
| 20 | T | 1 | 0.92 | 1 | 0.47 | 0.47 | 1 | 0.91 | 1 | 0.67 | 0.74 |
| 21 | U | 0 | 0 | 0.06 | 0.07 | 0 | 0.39 | 0.39 | 0.09 | 0.12 | 0.29 |
| 22 | V | 1 | 1 | 1 | 0.77 | 0.77 | 1 | 1 | 0.96 | 0.93 | 0.93 |
| 23 | W | 1 | 0.83 | 1 | 0.39 | 0.39 | 1 | 1 | 1 | 0.78 | 0.78 |

Table 6: Comparison of Traditional Cost Efficiency and Tone(2002)-IV

| | | 2011-12 | | | | | 2012-13 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **No.** | **Life Insurer** | **Tech** | **Ntech** | **Old Cost** | **Ncost** | **Nalloc** | **Tech** | **Ntech** | **Old Cost** | **Ncost** | **Nalloc** |
| 1 | A | 0.82 | 0.82 | 0.65 | 0.72 | 0.88 | 0.82 | 0.83 | 0.60 | 0.72 | 0.87 |
| 2 | B | 0.96 | 1 | 0.86 | 0.93 | 0.93 | 1 | 1 | 1 | 0.99 | 0.99 |
| 3 | C | 0.99 | 0.98 | 0.69 | 0.68 | 0.69 | 1 | 1 | 0.87 | 0.80 | 0.80 |
| 4 | D | 0.98 | 0.97 | 0.81 | 0.84 | 0.87 | 1 | 1 | 0.90 | 0.996 | 0.996 |
| 5 | E | 0.71 | 0.67 | 0.53 | 0.53 | 0.80 | 0.79 | 0.75 | 0.56 | 0.63 | 0.84 |
| 6 | F | 1 | 1 | 1 | 0.91 | 0.91 | 1 | 1 | 1 | 0.84 | 0.84 |
| 7 | G | 0.81 | 0.80 | 0.53 | 0.70 | 0.87 | 1 | 1 | 0.71 | 0.91 | 0.91 |
| 8 | H | 1 | 1 | 0.78 | 0.95 | 0.95 | 1 | 1 | 0.84 | 1 | 1 |
| 9 | I | 1 | 1 | 0.95 | 1 | 1 | 1 | 1 | 0.83 | 1 | 1 |
| 10 | J | 1 | 1 | 0.88 | 0.88 | 0.88 | 1 | 1 | 0.76 | 0.82 | 0.82 |
| 11 | K | 0.64 | 0.78 | 0.54 | 0.58 | 0.75 | 0.71 | 0.82 | 0.65 | 0.66 | 0.80 |
| 12 | L | 0.70 | 0.74 | 0.56 | 0.58 | 0.79 | 0.75 | 0.75 | 0.62 | 0.65 | 0.86 |
| 13 | M | 1 | 1 | 0.83 | 0.78 | 0.78 | 1 | 0.96 | 0.85 | 0.81 | 0.84 |
| 14 | N | 0.54 | 0.65 | 0.33 | 0.53 | 0.81 | 0.58 | 0.84 | 0.44 | 0.70 | 0.83 |
| 15 | O | 1 | 1 | 0.77 | 1 | 1 | 1 | 1 | 0.68 | 0.88 | 0.88 |
| 16 | P | 0.49 | 0.69 | 0.22 | 0.27 | 0.40 | 0.58 | 0.63 | 0.29 | 0.31 | 0.50 |
| 17 | Q | 0.63 | 0.63 | 0.21 | 0.34 | 0.54 | 0.56 | 0.56 | 0.30 | 0.38 | 0.68 |
| 18 | R | 0.55 | 0.56 | 0.36 | 0.48 | 0.85 | 0.73 | 0.69 | 0.53 | 0.57 | 0.83 |
| 19 | S | 0.50 | 0.50 | 0.13 | 0.22 | 0.43 | 0.52 | 0.55 | 0.21 | 0.28 | 0.51 |
| 20 | T | 1 | 0.91 | 1 | 0.87 | 0.96 | 1 | 0.90 | 1 | 0.79 | 0.88 |
| 21 | U | 0.50 | 0.50 | 0.11 | 0.16 | 0.32 | 0.64 | 0.64 | 0.16 | 0.18 | 0.28 |
| 22 | V | 1 | 1 | 0.90 | 0.99 | 0.99 | 1 | 0.80 | 0.78 | 0.77 | 0.97 |
| 23 | W | 1 | 1 | 1 | 0.95 | 0.95 | 1 | 1 | 1 | 1 | 1 |
| 24 | X | 0.04 | 0 | 0.01 | 0.02 | 0 | 0.23 | 0.23 | 0.05 | 0.07 | 0.32 |

Table 7: Comparison of Traditional Cost Efficiency and Tone(2002)-V

| | | 2013-14 | | | | | 2014-15 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **No.** | **Life Insurer** | **Tech** | **Ntech** | **Old Cost** | **Ncost** | **Nalloc** | **Tech** | **Ntech** | **Old Cost** | **Ncost** | **Nalloc** |
| 1 | A | 0.87 | 0.91 | 0.66 | 0.73 | 0.80 | 0.72 | 0.76 | 0.51 | 0.69 | 0.90 |
| 2 | B | 1 | 1 | 1 | 0.94 | 0.94 | 0.96 | 1 | 0.72 | 0.86 | 0.86 |
| 3 | C | 1 | 1 | 0.89 | 0.73 | 0.73 | 1 | 1 | 0.91 | 0.76 | 0.76 |
| 4 | D | 1 | 1 | 0.95 | 0.86 | 0.86 | 1 | 1 | 0.87 | 0.91 | 0.91 |
| 5 | E | 0.79 | 0.81 | 0.58 | 0.60 | 0.74 | 0.74 | 0.74 | 0.47 | 0.58 | 0.78 |
| 6 | F | 1 | 1 | 1 | 0.85 | 0.85 | 1 | 1 | 0.68 | 0.64 | 0.64 |
| 7 | G | 1 | 1 | 0.75 | 0.86 | 0.86 | 1 | 1 | 0.68 | 0.91 | 0.91 |
| 8 | H | 1 | 1 | 0.92 | 1 | 1 | 0.92 | 1 | 0.74 | 1 | 1 |
| 9 | I | 1 | 1 | 0.91 | 1 | 1 | 0.81 | 1 | 0.63 | 0.82 | 0.82 |
| 10 | J | 0.97 | 0.99 | 0.78 | 0.76 | 0.77 | 0.79 | 0.78 | 0.52 | 0.58 | 0.74 |
| 11 | K | 0.87 | 0.90 | 0.85 | 0.84 | 0.93 | 0.98 | 1 | 0.76 | 0.91 | 0.91 |
| 12 | L | 0.96 | 0.79 | 0.70 | 0.63 | 0.80 | 0.71 | 0.65 | 0.52 | 0.57 | 0.88 |
| 13 | M | 1 | 1 | 0.94 | 0.86 | 0.86 | 0.85 | 0.80 | 0.60 | 0.76 | 0.95 |
| 14 | N | 0.71 | 0.99 | 0.50 | 0.84 | 0.85 | 0.50 | 0.79 | 0.36 | 0.71 | 0.90 |
| 15 | O | 1 | 1 | 0.55 | 0.69 | 0.69 | 1 | 1 | 0.31 | 0.44 | 0.44 |
| 16 | P | 0.72 | 0.70 | 0.35 | 0.31 | 0.44 | 0.69 | 0.62 | 0.32 | 0.31 | 0.50 |
| 17 | Q | 0.62 | 0.60 | 0.36 | 0.39 | 0.64 | 0.53 | 0.57 | 0.30 | 0.38 | 0.67 |
| 18 | R | 0.74 | 0.76 | 0.57 | 0.53 | 0.70 | 0.78 | 0.81 | 0.56 | 0.63 | 0.77 |
| 19 | S | 0.57 | 0.60 | 0.26 | 0.27 | 0.45 | 0.50 | 0.51 | 0.25 | 0.27 | 0.53 |
| 20 | T | 1 | 1 | 1 | 1 | 1 | 1 | 0.96 | 1 | 0.91 | 0.95 |
| 21 | U | 0.72 | 0.72 | 0.20 | 0.21 | 0.29 | 1 | 1 | 0.48 | 0.47 | 0.47 |
| 22 | V | 0.79 | 0.74 | 0.64 | 0.58 | 0.77 | 0.84 | 0.84 | 0.59 | 0.65 | 0.77 |
| 23 | W | 1 | 1 | 1 | 0.94 | 0.94 | 1 | 1 | 1 | 1 | 1 |
| 24 | X | 0.37 | 0.37 | 0.09 | 0.11 | 0.29 | 0.71 | 0.71 | 0.17 | 0.19 | 0.27 |

Table 8: Comparison of Traditional Cost Efficiency and Tone(2002)-VI

| | | 2015-16 | | | | |
|---|---|---|---|---|---|---|
| **No.** | **Life Insurer** | **Tech** | **Ntech** | **Old Cost** | **Ncost** | **Nalloc** |
| 1 | A | 0.82 | 0.89 | 0.52 | 0.78 | 0.88 |
| 2 | B | 1 | 1 | 0.80 | 0.95 | 0.95 |
| 3 | C | 1 | 1 | 0.85 | 0.88 | 0.88 |
| 4 | D | 1 | 1 | 0.86 | 0.95 | 0.95 |
| 5 | E | 0.68 | 0.69 | 0.38 | 0.48 | 0.70 |
| 6 | F | 1 | 1 | 0.68 | 0.75 | 0.75 |
| 7 | G | 1 | 1 | 0.48 | 0.77 | 0.77 |
| 8 | H | 1 | 0.86 | 0.43 | 0.70 | 0.81 |
| 9 | I | 0.87 | 1 | 0.70 | 0.97 | 0.97 |
| 10 | J | 0.93 | 0.93 | 0.59 | 0.71 | 0.77 |
| 11 | K | 0.82 | 0.90 | 0.59 | 0.87 | 0.96 |
| 12 | L | 0.75 | 0.70 | 0.49 | 0.53 | 0.76 |
| 13 | M | 0.93 | 1 | 0.57 | 0.85 | 0.85 |
| 14 | N | 0.46 | 0.63 | 0.30 | 0.54 | 0.85 |
| 15 | O | 1 | 1 | 0.31 | 0.47 | 0.47 |
| 16 | P | 0.7411 | 0.66 | 0.32 | 0.35 | 0.53 |
| 17 | Q | 0.57 | 0.62 | 0.26 | 0.34 | 0.54 |
| 18 | R | 0.83 | 0.90 | 0.59 | 0.72 | 0.80 |
| 19 | S | 0.581 | 0.65 | 0.23 | 0.28 | 0.43 |
| 20 | T | 1 | 1 | 1 | 1 | 1 |
| 21 | U | 1 | 1 | 0.45 | 0.51 | 0.51 |
| 22 | V | 0.98 | 0.91 | 0.55 | 0.68 | 0.75 |
| 23 | W | 1 | 1 | 0.94 | 1 | 1 |
| 24 | X | 0.70 | 0.70 | 0.19 | 0.24 | 0.34 |

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