Cost Efficiency of Indian Life Insurance Service Providers using Data Envelopment Analysis

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Abstract

This study examines the cost efficiency of Indian life insurance service providers using Data Envelopment Analysis. The study was performed for a sample of fifteen of the major life insurance companies in India, accounting for 94.77% of the total market for life insurance in India, over the period of 2010-17. The study extends the scope of cost efficiency by disaggregating the premium collection into components. Also, to provide more detailed insights, the efficiency of the life insurance companies is also analysed with respect to each input and output individually.

The results of the study show that the most efficient Indian life insurance companies are Life Insurance Corporation, which has been consistently 100% efficient throughout the research period, followed by SBI Life and ICICI Prudential Life, which have also shown consistently high efficiency over the research period. On the other hand, the least efficient life insurance companies are Max New York Life, followed by PNB Met Life, Reliance Life, and Bharati AXA Life. The results of the study also indicate the strengths and weaknesses of the Indian life insurance providers.

Keywords: cost efficiency, life insurance service providers, Data Envelopment Analysis.

Introduction

Traditionally, India is a country of savers, with household savings either lying idle or invested in non-productive physical assets such as real estate and gold. This is a worrying trend as the savings are getting trapped into non-productive physical assets. In developed countries, insurance is mandatory by law. In developing countries like India, the need for financial security is much greater, as the poor and the middle class constitute a large segment of more than one billion population. The vulnerability to risk of this segment is much greater than the opportunities available to them to recover from a large loss. Life insurance provides financial security against unforeseen circumstances such as death of earning family members.

The Indian insurance industry has been witnessing a period of tremendous growth with the advent of Liberalisation, Privatization, and Globalization policies in the early 1990s. Following the separation of non-life and life businesses of the Insurance market, the number of players has increased drastically. With the increase in the number of players, the growing awareness among the middle-class population, convenience in investing, and the tax benefits, the trend is slowly bending towards insurance and in particular, life insurance.

There are now twenty-four companies operating in India's life insurance market, of which the Life Insurance Corporation (LIC) is the lone public sector company and the other twenty-three companies belong to private sector. In the last few years, the private players have made steady progress in terms of business growth. The prime business operational goal of these players is performance, efficiency, and effectiveness. Efficiency is one of the major concerns for further development of the insurance industry and increased profitability. The list of all registered life insurance companies in India is presented in Table 1 below.

Table 1. Registered life insurance companies in India

1	**Bajaj Allianz Life**	13	**Sahara Life**
2	**Exide Life**	14	**Shriram Life**
3	**Reliance Life**	15	**Bharti Axa Life**
4	**SBI Life**	16	**Future Generali Life**
5	**Tata AIA Life**	17	**IDBI Federal Life**
6	**HDFC Standard Life**	18	**Canara HSBC OBC Life**
7	**ICICI Prudential Life**	19	**Aegon Life**
8	**Birla Sun Life**	20	**DHFL Pramerica Life**
9	**Aviva Life**	21	**Star Union Dai-Ichi Life**
10	**Kotak Mahindra Old Mutual Life**	22	**IndiaFirst Life**
11	**Max Life**	23	**Edelweiss Tokio Life**
12	**PNB Met Life**	24	**Life Insurance Corporation**

Over the next ten years, the life insurance market in India is slated to cross US$ 160 billion making it a huge business opportunity. India currently accounts for only 2% of the world's life insurance premiums though it is the second most populous nation. It is the fifteenth largest insurance market in the world in terms of premium volume, and has the potential to grow exponentially in the coming years. Life insurance is emerging as one of the big saving

instruments and the future looks promising for the industry. India's insurable population is expected to touch 750 million in 2020, and life insurance is expected to comprise 35% of total savings by the end of this decade, as against 26% in 2009-10.

The Indian life insurance industry grew at 22.55% new business premium in 2015-16, due to the high growth in the group single premium policy, with private insurers growing at 17.63% and Life Insurance Corporation of India registering a higher growth at 24.74%.The industry is expected to grow at15% for the next five years.

Literature Review

There have been several studies examining the efficiency of life insurance companies. Much of the literature on insurance efficiency is for developed countries, particularly for the US insurance industry (Gardner and Grace, 1993; Yuengert, 1993; Cummins et al, 1999; Greene and Segal, 2004). The following is a review of some of the pertinent efficiency studies in the Indian life insurance context.

The two most common approaches used for efficiency measurement are Data Envelopment Analysis (DEA) and the Stochastic Frontier Approach (SFA). DEA is a nonparametric method that is useful particularly for efficiency measurement for companies in service industries, as it does not require explicit functional form of the production function nor assumptions on the distribution of the inefficiency or random error terms which are required in SFA (Sinha and Chatterjee, 2009). Jarraya and Bouri (2012) provides an extensive survey of different efficiency concepts and measurement methods in the insurance industry. Wise (2017) provides an even more elaborate discussion on the same.

Sinha and Chatterjee (2009) estimated cost efficiency of the life insurance companies operating in India for the period 2002-07 using a modified DEA model approach. They found a trend increase in cost efficiency in 2002-05, which reversed in 2005-07.

Shinde (2012) and Noronh and Shinde (2012) evaluated the cost efficiency of life insurance companies operating in India in the period 2000-10 using DEA. The inputs considered were operational expenditure and commissions paid, while the outputs were benefits paid and net premium. They found Life Insurance Corporation of India to consistently secure a cost efficiency score of 100%, while the cost efficiency score in the case of the private life insurance companies was not very consistent.

Sinha (2015) used a dynamic slacks-based DEA model for measuring the efficiency of life insurance companies in India in the period 2005-12. His results indicated that there was a decline in mean technical efficiency scores for2011-12 as compared to 2008-09, due to the slowdown in the life insurance industry. He also found that the mean technical efficiency of the life insurance companies fluctuated significantly during the research period.

Nandi (2014) examined the efficiency of the top thirteen life insurance companies of India in the period 2002-12 using DEA. The study utilized two inputs, viz. commission paid and operating expenses, and two outputs, viz. premium and net benefit. He estimated the average technical efficiency of the life insurance companies to be 82.6%, pure technical efficiency 87.5%

and scale efficiency 94.7%. He also found that Life Insurance Corporation of India was far more efficient than the other life insurance companies.

Bawa and Bhagat (2015) examined the efficiency of life insurance companies registered in Punjab in the period 2006-13 using DEA. They used the number of agents and the number of offices as inputs and net premium and the number of policies as outputs. They found that LIC was 100% efficient in all the years, and that Aviva Life and SBI Life were 100% efficient in the first four years of the study period. They estimated the average technical efficiency of life insurance companies in Punjab to be 55.0%, pure technical efficiency 67.9%, and scale efficiency 80.5%.

The review of literature indicates that DEA is the most appropriate technique for efficiency measurement in the life insurance industry. The cost efficiency concept, using commission paid and operating expenses as inputs and net premium and benefits as outputs, is used by most of the studies in the context of the Indian life insurance industry.

Methodology

The objective of the study is to examine the cost efficiency of life insurance providers in India. To this end, the study uses Data Envelopment Analysis to measure cost efficiency of Indian life insurance service providers. Also, it explores the relationship between efficiency and market power in the Indian life insurance industry.

The analysis was performed for fifteen of the twenty-four registered life insurance service providers, accounting for 94.77% of the total market for life insurance in India. The list of sample companies is presented in the table 2 below.

Table 2.

Bajaj Allianz Life	**Max New York Life**
Reliance Life	**PNB Met Life**
SBI Life	**Bharti AXA Life**
HDFC Standard Life	**Future Generali Life**
ICICI Prudential Life	**IDBI Federal Life**
Birla Sun Life	**Aegon Life**
Aviva Life	**Edelweiss Tokio Life**
Life Insurance Corporation	

The data for the service providers was obtained from the IRDA (Note 1), Life Insurance Council of India (LICI)(Note 2) and the public disclosures from the insurers' websites (Note 3). The data for the study was taken on a quarterly basis for the period 2010-17.

The efficiency of the life insurance service providers was measured using data envelopment analysis (Farrell, 1957; Charnes et al, 1978; Banker et al, 1984). Data envelopment analysis is a non-parametric technique that identifies the proportion of a DMU's inputs that are effectively required to produce its given levels of outputs, as compared to other DMUs. Mathematically, it is formulated as a linear programming problem follows:

$$
\min E \quad s.t. \quad
\begin{aligned}
\sum w_j &= 1 \\
\sum w_j I_{ij} &\leq E.I_{i*} \\
\sum w_j O_{ij} &\geq O_{i!*}
\end{aligned}
$$

In the above formulation, the weights w_j are associated with the jth DMU; I_{ij} represents the quantity of the ith input used by the jth DMU; and O_{ij} represents the quantity of the ith output produced by the jth DMU. The target DMU's inputs and outputs are represented by I_i* and O_i*, respectively, and the efficiency score of the target DMU is represented as E. If the target DMU is not efficient, the formulation above describes a composite of the remaining DMUs that produces at least as much of all the target DMU's outputs using a fraction of its inputs. The efficiency score in this case is the least such fraction. On the other hand, if the target DMU is efficient, in the sense that it is not possible to produce at least as much of all outputs using a fraction of the inputs, its efficiency score is 100%.

In the context of financial service firms, there are three major approaches to measure outputs: the asset or intermediation approach, the user-cost approach, and the value-added approach (Berger and Humphrey, 1992).The asset/intermediation approach views financial service firms purely as financial intermediaries, borrowing funds from customers and transforming the into assets by investing them, and compensating the time value of the funds used through interest payments. However, this approach only considers the intermediation services provided by life insurance firms, ignoring their risk-pooling and risk-bearing functions.

The user-cost approach (Hancock, 1985) classifies financial instruments as an inputs or outputs by analysing if their net contribution to the revenues of the firm is positive or negative. If the returns of an asset exceed the opportunity costs of funds or if the costs of a liability are lower than the opportunity costs, the product is considered as an output; otherwise it is categorised as an input. However, this approach requires detailed information on product revenues and opportunity costs which are difficult to obtain for Indian life insurance firms.

The value-added approach considers all assets and liabilities with substantial value added as the major outputs, and the remaining assets and liabilities are treated either as unimportant outputs, intermediate products, or inputs. This approach is considered most appropriate for measuring output of financial firms and is widely used in insurance studies (Sinha, 2015).

For the present study, the inputs considered include the commissions expenses, operating expenses, and net benefits paid, while the outputs considered include the individual single premium, individual non-single premium, group single premium, and group non-single premium. This is similar to the approach of Shinde (2012), Noronh and Shinde (2012), and Nandi (2014), who used a similar concept of cost efficiency in the context of life insurance firms. By disaggregating premium collections, the efficiency estimates would be expected to be more sensitive. In the research period, individual single premium accounted for 17.26% of the total premium collection, individual non-single premium accounted for 36.02%, group single premium 37.80%, and group non-single 8.93%. In the last two/three years, years, however, there has been a shift towards group single premium, with about 15% of total premium collection from individual single premium, about 30%-33% from individual

non-single premium, 46%-50% from group single premium, and 5%-7% from group non-single premium.

To provide more detailed insights, the efficiency of the sample life insurance companies was also analysed with respect to each input and output individually. Further, to examine the relationship of efficiency with market power (Chuang and Tang, 2015), the resultant efficiency scores were plotted against market shares.

Findings

The descriptive statistics of the overall efficiency scores for the sample life insurance companies are presented in Table 3 below.

Table 3. Descriptive statistics of overall efficiency scores for the sample life insurance companies

	average	std dev	coeff var
Aegon Life	86.71%	24.91%	28.73%
Aviva Life	93.92%	12.99%	13.83%
Bajaj Allianz Life	93.29%	18.33%	19.65%
Bharati AXA Life	79.79%	29.78%	37.32%
Birla SunLife	82.04%	25.46%	31.03%
Edelweiss Tokio Life	94.74%	22.94%	24.22%
Future Generali Life	83.42%	27.36%	32.80%
HDFC Life	88.46%	19.17%	21.67%
ICICI Prudential Life	96.22%	19.23%	19.99%
IDBI Federal Life	92.95%	24.81%	26.70%
Life Insurance Corporation	100.00%	0.00%	0.00%
Max New York Life	52.22%	31.94%	61.16%
PNB Met Life	69.60%	28.69%	41.21%
Reliance Life	74.89%	23.28%	31.09%
SBI Life	96.65%	8.16%	8.44%

The efficiency scores indicate that Life Insurance Corporation has been consistently 100% efficient throughout the research period. SBI Life and ICICI Prudential Life have also shown consistently high efficiency over the research period. The least efficient of the sample life insurance companies was Max New York Life, followed by PNB Met Life and Reliance Life. Bharati AXA Life was also relatively less efficient, and showed high variability in efficiency over the research period.

The descriptive statistics of the efficiency scores with respect to commissions paid (against all of the outputs) for the sample life insurance companies are presented in Table 4 below.

Table 4. descriptive statistics of efficiency scores w.r.t. commissions paid for the sample life insurance companies

	average	std dev	coeff var
Aegon Life	76.77%	41.85%	54.51%
Aviva Life	82.64%	29.47%	35.66%
Bajaj Allianz Life	93.05%	21.59%	23.20%
Bharati AXA Life	64.48%	40.22%	62.37%
Birla Sun Life	91.37%	21.92%	23.99%
Edelweiss Tokio Life	77.67%	39.29%	50.58%
Future Generali Life	81.54%	31.66%	38.83%
HDFC Life	92.45%	26.66%	28.83%
ICICI Prudential Life	95.13%	19.96%	20.98%
IDBI Federal Life	79.42%	36.15%	45.52%
Life Insurance Corporation	100.00%	0.00%	0.00%
Max New York Life	44.39%	31.62%	71.24%
PNB Met Life	74.00%	26.91%	36.37%
Reliance Life	75.64%	24.95%	32.98%
SBI Life	90.07%	28.05%	31.14%

Life Insurance Corporation was found to be consistently 100% efficient throughout the research period with respect to commissions paid. ICICI Prudential Life and Bajaj Allianz Life were also found to be consistently highly efficient over the research period. The least efficient of the sample life insurance companies was Max New York Life, followed by Bharati AXA Life, PNB Met Life, and Reliance Life. Aegon Life and Edelweiss Tokio Life were also relatively less efficient, and showed high variability over the research period.

The descriptive statistics of the efficiency scores with respect to operational expenses (against all of the outputs) for the sample life insurance companies are presented in Table 5 below.

Table 5. descriptive statistics of efficiency scores w.r.t. operational expenses for the sample life insurance companies

	average	std dev	coeff var
Aegon Life	78.14%	23.58%	30.18%
Aviva Life	87.12%	18.65%	21.41%
Bajaj Allianz Life	91.53%	17.41%	19.02%
Bharati AXA Life	53.44%	27.59%	51.63%
Birla Sun Life	95.86%	16.36%	17.06%
Edelweiss Tokio Life	100.00%	0.00%	0.00%
Future Generali Life	72.02%	30.58%	42.46%
HDFC Life	97.30%	29.32%	30.13%
ICICI Prudential Life	89.79%	16.06%	17.89%
IDBI Federal Life	93.32%	20.82%	22.31%
Life Insurance Corporation	100.00%	0.00%	0.00%
Max New York Life	55.17%	31.56%	57.21%
PNB Met Life	73.62%	25.03%	34.00%
Reliance Life	80.19%	21.20%	26.43%
SBI Life	99.30%	3.66%	3.69%

Life Insurance Corporation and Edelweiss Tokio Life were found to be consistently 100% efficient throughout the research period with respect to operational expenses. SBI Life was also found to be consistently highly efficient over the research period. HDFC Life was also relatively highly efficient, but with higher variability. The least efficient of the sample life insurance companies was Bharati AXA Life, followed by Max New York Life, Future Generali Life, PNB Met Life, and Aegon Life. Bharati AXA Life and Max New York Life also had high variability in efficiency over the research period.

The descriptive statistics of the efficiency scores with respect to individual single premium (against all of the inputs) for the sample life insurance companies are presented in Table 6 below.

Table 6. Descriptive statistics of efficiency scores w.r.t. individual single premium for the sample life insurance companies

	average	std dev	coeff var
Aegon Life	72.27%	33.86%	46.85%
Aviva Life	42.69%	23.68%	55.47%
Bajaj Allianz Life	74.71%	28.58%	38.25%
Bharati AXA Life	41.78%	25.48%	60.98%
Birla Sun Life	16.70%	7.21%	43.20%
Edelweiss Tokio Life	93.98%	14.61%	15.54%
Future Generali Life	60.71%	31.37%	51.66%
HDFC Life	33.87%	23.58%	69.62%
ICICI Prudential Life	24.69%	27.44%	111.13%
IDBI Federal Life	90.86%	23.32%	25.67%
Life Insurance Corporation	100.00%	0.00%	0.00%
Max New York Life	24.98%	21.36%	85.51%
PNB Met Life	47.93%	32.39%	67.57%
Reliance Life	22.30%	12.90%	57.86%
SBI Life	79.79%	25.57%	32.05%

Life Insurance Corporation was found to be consistently 100% efficient throughout the research period with respect to individual single premium. Edelweiss Tokio Life and IDBI Federal Life were also found to be consistently highly efficient over the research period. The least efficient of the sample life insurance companies was Birla Sun Life, followed by Reliance Life, ICICI Prudential Life, and Max New York Life, all of which had relatively high variability in efficiency over the research period.

The descriptive statistics of the efficiency scores with respect to individual non-single premium (against all of the inputs) for the sample life insurance companies are presented in Table7 below.

Table 7. descriptive statistics of efficiency scores w.r.t. individual non-single premium for the sample life insurance companies

	average	std dev	coeff var
Aegon Life	58.58%	43.10%	73.58%
Aviva Life	52.09%	35.97%	69.05%
Bajaj Allianz Life	58.42%	33.25%	56.91%
Bharati AXA Life	48.32%	38.32%	79.31%
Birla Sun Life	51.47%	25.60%	49.75%
Edelweiss Tokio Life	57.87%	46.18%	79.79%
Future Generali Life	50.61%	34.11%	67.40%
HDFC Life	86.76%	18.84%	21.71%
ICICI Prudential Life	81.89%	25.77%	31.47%
IDBI Federal Life	65.35%	43.05%	65.88%
Life Insurance Corporation	100.00%	0.00%	0.00%
Max New York Life	29.27%	21.74%	74.25%
PNB Met Life	57.93%	30.93%	53.40%
Reliance Life	49.91%	26.88%	53.86%
SBI Life	93.45%	12.09%	12.93%

Life Insurance Corporation was found to be consistently 100% efficient throughout the research period with respect to individual single premium. SBI Life was also found to be consistently highly efficient over the research period, followed by HDFC Life and ICICI Prudential Life. The least efficient of the sample life insurance companies was Max New York Life, followed by Bharati AXA Life and Reliance Life. In fact, most of the sample life insurance companies had relatively low efficiency and relatively high variability in efficiency over the research period.

The descriptive statistics of the efficiency scores with respect to group single premium (against all of the inputs) for the sample life insurance companies are presented in Table 8 below.

Table 8. Descriptive statistics of efficiency scores w.r.t. group single premium for the sample life insurance companies

	average	std dev	coeff var
Aegon Life	83.59%	25.54%	30.55%
Aviva Life	49.95%	23.61%	47.28%
Bajaj Allianz Life	68.99%	39.46%	57.20%
Bharati AXA Life	59.29%	26.73%	45.08%
Birla Sun Life	15.59%	7.67%	49.21%
Edelweiss Tokio Life	91.30%	23.39%	25.62%
Future Generali Life	62.32%	18.11%	29.07%
HDFC Life	58.34%	34.16%	58.55%
ICICI Prudential Life	13.64%	15.83%	116.08%
IDBI Federal Life	87.60%	22.61%	25.82%
Life Insurance Corporation	100.00%	0.00%	0.00%
Max New York Life	7.32%	5.14%	70.24%
PNB Met Life	27.27%	12.80%	46.95%
Reliance Life	12.91%	7.63%	59.05%
SBI Life	78.63%	30.85%	39.24%

Life Insurance Corporation was found to be consistently 100% efficient throughout the research period with respect to group single premium. Edelweiss Tokio Life and IDBI Federal Life were also found to be relatively highly efficient over the research period. The least efficient of the sample life insurance companies was Max New York Life, followed by Reliance Life, ICICI Prudential Life, and Birla Sun Life.

The descriptive statistics of the efficiency scores with respect to group non-single premium (against all of the inputs) for the sample life insurance companies are presented in Table 9 below.

Table 9. descriptive statistics of efficiency scores w.r.t. group non-single premium for the sample life insurance companies

	average	std dev	coeff var
Aegon Life	75.66%	37.32%	49.33%
Aviva Life	56.37%	36.50%	64.74%
Bajaj Allianz Life	66.32%	34.84%	52.53%
Bharati AXA Life	42.71%	27.85%	65.20%
Birla Sun Life	82.94%	29.44%	35.50%
Edelweiss Tokio Life	63.79%	45.51%	71.35%
Future Generali Life	44.16%	37.92%	85.88%
HDFC Life	23.83%	26.67%	111.88%
ICICI Prudential Life	29.46%	39.27%	133.30%
IDBI Federal Life	75.47%	34.78%	46.08%
Life Insurance Corporation	91.11%	26.00%	28.53%
Max New York Life	6.12%	7.87%	128.72%
PNB Met Life	30.41%	23.57%	77.53%
Reliance Life	43.25%	35.59%	82.27%
SBI Life	30.55%	29.30%	95.91%

The efficiency scores with respect to group non-single premium showed relatively high variability for all of the sample insurance companies. Life Insurance Corporation and Birla Sun Life were found to be consistently highly efficient throughout the research period with respect to group non-single premium. The least efficient of the sample life insurance companies was Max New York Life, followed by HDFC Life and ICICI Prudential Life.

The relationship between overall efficiency and market share for the sample private life insurance companies are presented in Table 10 and Figure 1 below.

Table 10. Overall efficiency vs. market share

	average efficiency	market share
Aegon Life	86.71%	0.14%
Aviva Life	93.92%	0.48%
Bajaj Allianz Life	93.29%	2.31%
Bharati AXA Life	79.79%	0.32%
Birla Sun Life	82.04%	1.62%
Edelweiss Tokio Life	94.74%	0.08%
Future Generali Life	83.42%	0.24%
HDFC Life	88.46%	3.76%
ICICI Prudential Life	96.22%	4.58%
IDBI Federal Life	92.95%	0.52%
Max New York Life	52.22%	1.91%
PNB Met Life	69.60%	0.71%
Reliance Life	74.89%	1.57%
SBI Life	96.65%	5.13%
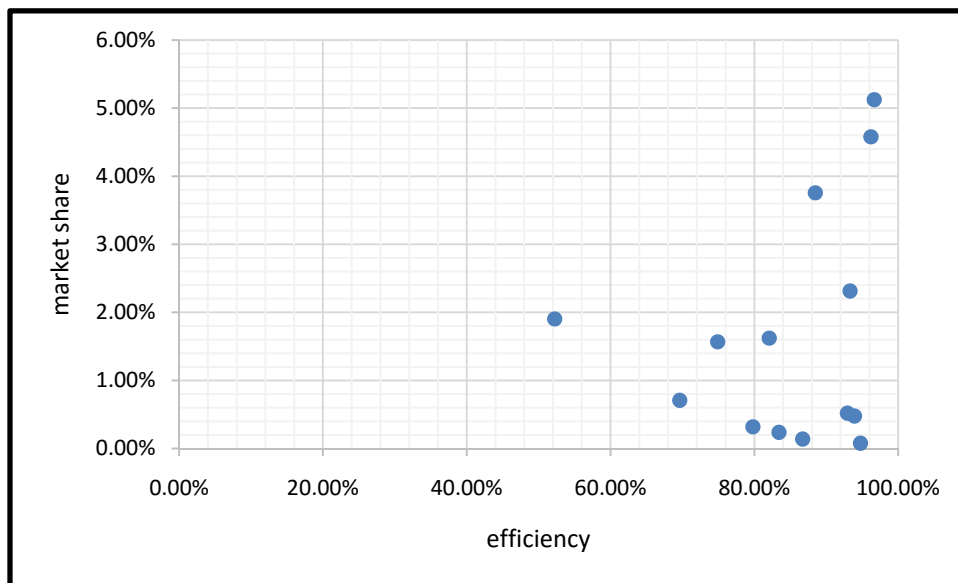
Figure 1. Overall efficiency vs. market share

There was generally a positive relationship between overall efficiency and market share, with some exceptions. However, for each individual insurance company, the relationship between overall efficiency and market share was not statistically significant.

The relationship between efficiency with respect to commissions paid and market share for the sample private life insurance companies are presented in Table 11 and Figure 2 below.

Table 11. Efficiency w.r.t. commissions paid vs. market share

	average efficiency	market share
Aegon Life	76.77%	0.14%
Aviva Life	82.64%	0.48%
Bajaj Allianz Life	93.05%	2.31%
Bharati AXA Life	64.48%	0.32%
Birla Sun Life	91.37%	1.62%
Edelweiss Tokio Life	77.67%	0.08%
Future Generali Life	81.54%	0.24%
HDFC Life	92.45%	3.76%
ICICI Prudential Life	95.13%	4.58%
IDBI Federal Life	79.42%	0.52%
Max New York Life	44.39%	1.91%
PNB Met Life	74.00%	0.71%
Reliance Life	75.64%	1.57%
SBI Life	90.07%	5.13%
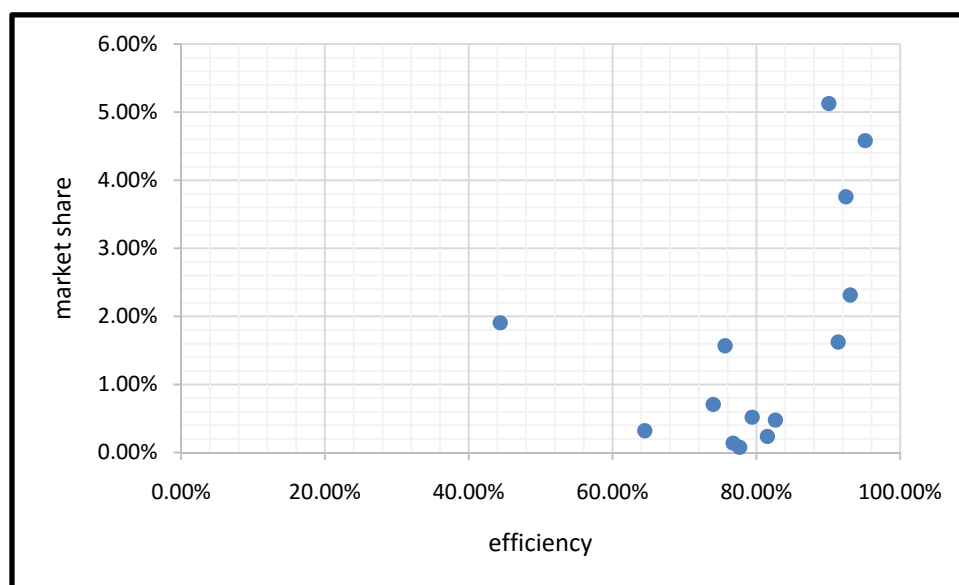
Figure 2. Efficiency w.r.t. commissions paid vs. market share

There was generally a positive relationship between efficiency with respect to commissions paid and market share, with some exceptions.

The relationship between efficiency with respect to operational expenses and market share for the sample private life insurance companies are presented in Table 12 and Figure 3 below.

Table 12. Efficiency w.r.t. operational expenses vs. market share

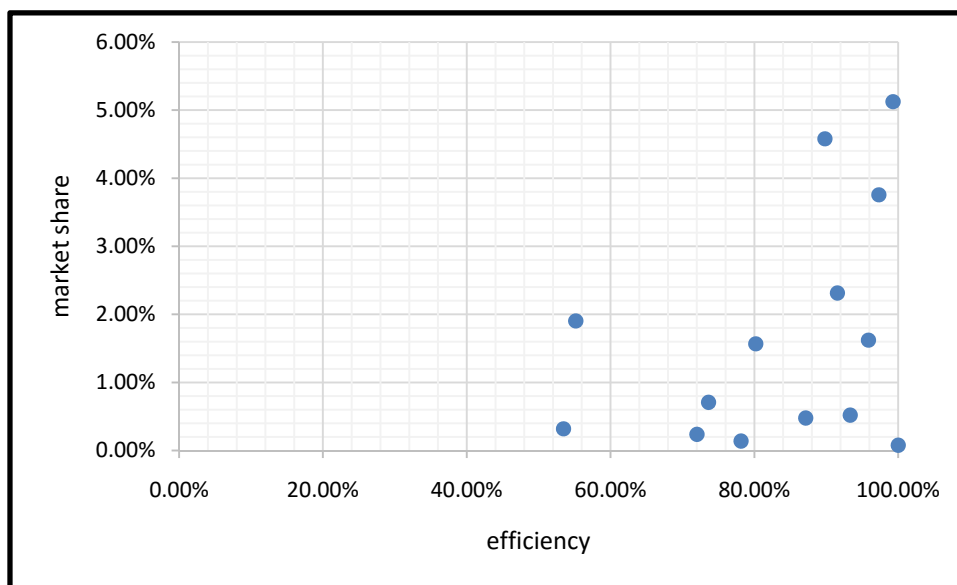|	average efficiency	market share
Aegon Life	78.14%	0.14%
Aviva Life	87.12%	0.48%
Bajaj Allianz Life	91.53%	2.31%
Bharati AXA Life	53.44%	0.32%
Birla Sun Life	95.86%	1.62%
Edelweiss Tokio Life	100.00%	0.08%
Future Generali Life	72.02%	0.24%
HDFC Life	97.30%	3.76%
ICICI Prudential Life	89.79%	4.58%
IDBI Federal Life	93.32%	0.52%
Max New York Life	55.17%	1.91%
PNB Met Life	73.62%	0.71%
Reliance Life	80.19%	1.57%
SBI Life	99.30%	5.13%

Figure 3. Efficiency w.r.t. operational expenses vs. market share

There was generally a positive relationship between efficiency with respect operational expenses and market share, with some exceptions.

The relationship between efficiency with respect to individual single premium and market share for the sample private life insurance companies are presented in Table 13 and Figure 4 below.

Table 13. Efficiency w.r.t. individual single premium vs. market share

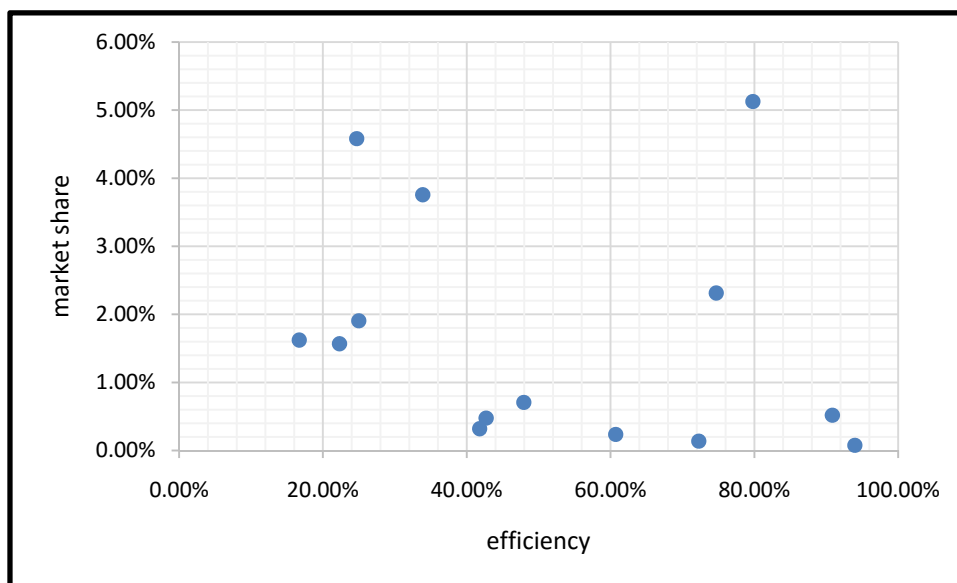|	average efficiency	market share
Aegon Life	72.27%	0.14%
Aviva Life	42.69%	0.48%
Bajaj Allianz Life	74.71%	2.31%
Bharati AXA Life	41.78%	0.32%
Birla Sun Life	16.70%	1.62%
Edelweiss Tokio Life	93.98%	0.08%
Future Generali Life	60.71%	0.24%
HDFC Life	33.87%	3.76%
ICICI Prudential Life	24.69%	4.58%
IDBI Federal Life	90.86%	0.52%
Max New York Life	24.98%	1.91%
PNB Met Life	47.93%	0.71%
Reliance Life	22.30%	1.57%
SBI Life	79.79%	5.13%

Figure 4. Efficiency w.r.t. individual single premium vs. market share

The relationship between efficiency with respect to individual non-single premium and market share for the sample private life insurance companies are presented in Table 14 and Figure 5 below.

Table 14. Efficiency w.r.t. individual non-single premium vs. market share

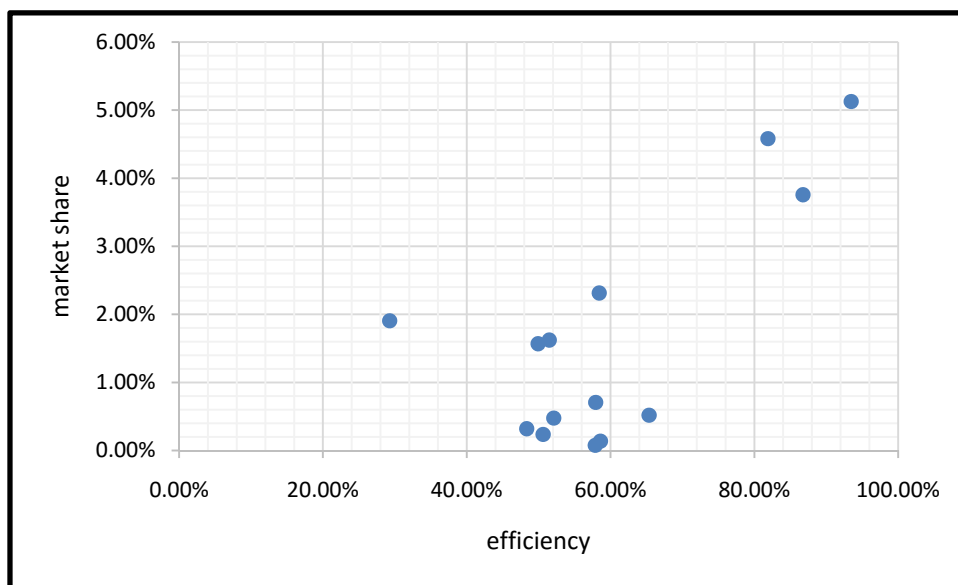|	average efficiency	market share
Aegon Life	58.58%	0.14%
Aviva Life	52.09%	0.48%
Bajaj Allianz Life	58.42%	2.31%
Bharati AXA Life	48.32%	0.32%
Birla Sun Life	51.47%	1.62%
Edelweiss Tokio Life	57.87%	0.08%
Future Generali Life	50.61%	0.24%
HDFC Life	86.76%	3.76%
ICICI Prudential Life	81.89%	4.58%
IDBI Federal Life	65.35%	0.52%
Max New York Life	29.27%	1.91%
PNB Met Life	57.93%	0.71%
Reliance Life	49.91%	1.57%
SBI Life	93.45%	5.13%

Figure 5. Efficiency w.r.t. individual non-single premium vs. market share

The relationship between efficiency with respect to group single premium and market share for the sample private life insurance companies are presented in Table 15 and Figure 6 below.

Table 15. Efficiency w.r.t. group single premium vs. market share

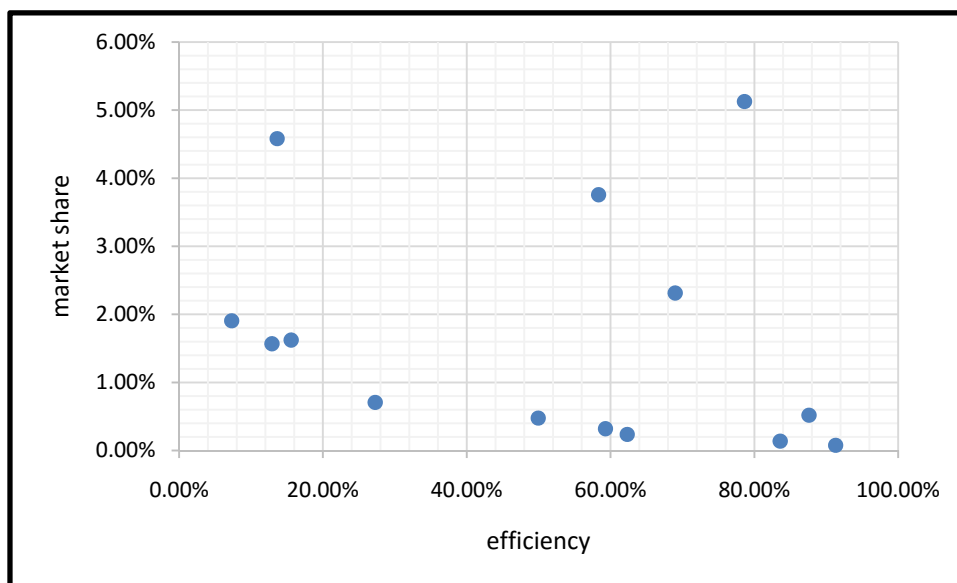|	average efficiency	market share
Aegon Life	83.59%	0.14%
Aviva Life	49.95%	0.48%
Bajaj Allianz Life	68.99%	2.31%
Bharati AXA Life	59.29%	0.32%
Birla Sun Life	15.59%	1.62%
Edelweiss Tokio Life	91.30%	0.08%
Future Generali Life	62.32%	0.24%
HDFC Life	58.34%	3.76%
ICICI Prudential Life	13.64%	4.58%
IDBI Federal Life	87.60%	0.52%
Max New York Life	7.32%	1.91%
PNB Met Life	27.27%	0.71%
Reliance Life	12.91%	1.57%
SBI Life	78.63%	5.13%

Figure 6. Efficiency w.r.t. group single premium vs. market share

The relationship between efficiency with respect to group non-single premium and market share for the sample private life insurance companies are presented in Table 16 and Figure 7 below.

Table 16. efficiency w.r.t. group non-single premium vs. market share

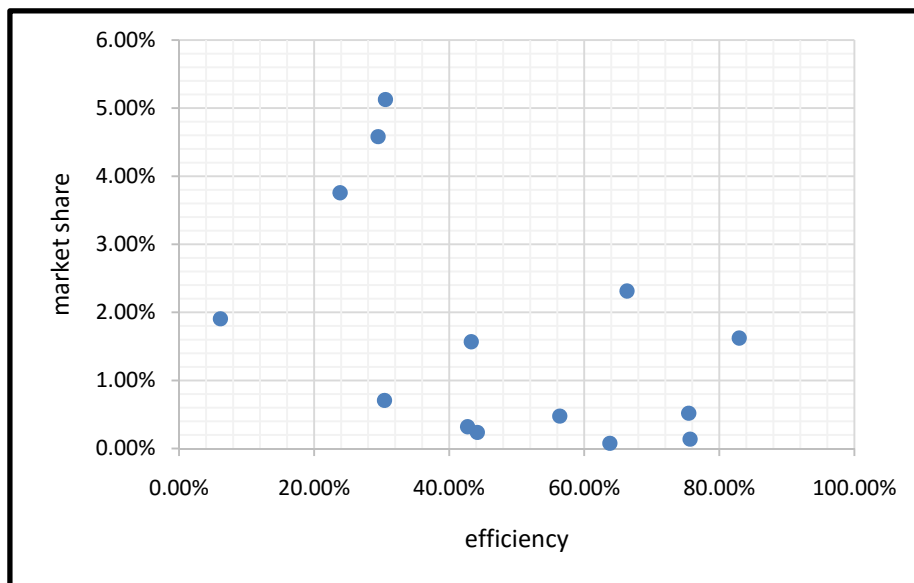|	average efficiency	market share
Aegon Life	75.66%	0.14%
Aviva Life	56.37%	0.48%
Bajaj Allianz Life	66.32%	2.31%
Bharati AXA Life	42.71%	0.32%
Birla Sun Life	82.94%	1.62%
Edelweiss Tokio Life	63.79%	0.08%
Future Generali Life	44.16%	0.24%
HDFC Life	23.83%	3.76%
ICICI Prudential Life	29.46%	4.58%
IDBI Federal Life	75.47%	0.52%
Max New York Life	6.12%	1.91%
PNB Met Life	30.41%	0.71%
Reliance Life	43.25%	1.57%
SBI Life	30.55%	5.13%

Figure 7. Efficiency w.r.t. group non-single premium vs. market share

There was generally a positive relationship between efficiency with respect individual non-single premium and market share, but the relationship between efficiency with respect to other outputs and market share was mixed.

Discussion

The results of the study show that the most efficient Indian life insurance companies are Life Insurance Corporation, which has been consistently 100% efficient throughout the research period, followed by SBI Life and ICICI Prudential Life, which have also shown consistently

high efficiency over the research period. On the other hand, the least efficient life insurance companies are Max New York Life, followed by PNB Met Life, and Reliance Life. Bharati AXA Life is also relatively less efficient, with high variability in efficiency over the research period. The results of the analysis of efficiency with respect to individual inputs and outputs were similar, with Life Insurance Corporation almost always 100% efficient throughout the research period, along with SBI Life and ICICI Prudential Life at the higher end, and Max New York Life, PNB Met Life, Reliance Life, and Bharati AXA Life at the lower end.

The results of the study emphasise that Life Insurance Corporation is the dominant player in the Indian life insurance industry. This conforms with the results of most previous studies (Shinde, 2012, Noronh and Shinde, 2012; Nandi, 2014; Bawa and Bhagat, 2015). Life Insurance Corporation was found to be 100% efficient in all the analyses except for efficiency with respect to group non-single premium. This could be an effect of the decline in this sub-segment of the life insurance industry in recent years.

The results suggest very high variability in efficiency of most of the sample life insurance companies. This conforms with the results of Sinha and Chatterjee (2009) and Sinha (2015). It is a possibility that life insurance business is affected by seasonality. The two expected peak seasons are Q2 and Q4. The former, Q2, is expected to be a peak as it is the festival season in India, and almost all sectors have a spurt in sales in this quarter. The latter, Q4, is the close of the financial year, and many individuals and firms tend to buy insurance in this quarter, for example, to manage their investments and tax deductions. The data for the current study was taken for this reason. Unfortunately, apart from some evidence in seasonality in the market share of Life Insurance Corporation in the early part of the research period (with a low in Q3), no seasonality in the efficiency scores was identifiable.

There are some limitations inherent in the study. The data for the study was censored to some extent; in some years, some data was unavailable. For example, cost data for Future Generali Life was not available for the year 2015-16 and Q3 of 2016-17. Also, Edelweiss Tokio Life entered the industry in 2011-12, and its cost data was available only from Q1 of 2012-13. The efficiency scores may thus be somewhat biased.

A limitation of DEA is that the results are generally sensitive to the choice of inputs and outputs (Gutierrez-Nieto et al., 2007). Although the study has extended the concept of cost efficiency by disaggregating the outputs, the results are not really very different from those of earlier studies. Some in efficiencies that have been identified need to be analysed further, particularly for the weak players, viz. Max New York Life, PNB Met Life, Reliance Life, and Bharati AXA Life, in order to understand how they can improve their efficiency.

There is a scope to include more variables in the analysis to refine the efficiency score. Also, the study may be extended by analysing the critical factors predicting inefficiency. This would be of interest to regulators to help identify inefficient players.

Another limitation of DEA is that it may overestimate the efficiency of the smallest and largest DMUs. This could have distorted the efficiency estimates for the smaller players, for example, for Edelweiss Tokio Life, even if the outputs are negligible.

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Notes
Note 1. https://www.irdai.gov.in/
Note 2. http://www.lifeinscouncil.org/
Note   3. https://www.lifeinscouncil.org/industry%20information/Public_Disclosures.aspx