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Efficiency of Indian Private Non-Life Insurance Firms using Stochastic Frontier Analysis

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Abstract: *The purpose of this paper is to measure the relative efficiency of non-life insurance companies in India from 2008 to 2013 by using Stochastic Frontier Analysis. It is found that BharatiAXA is at rank one and it has a relative efficiency score higher than all other companies. Since $\gamma = 0.9251$ which is close to one indicates that all the residual variations are due to the inefficiency effects. It is also found that the mean of efficiency score of non-life insurance companies is increasing from year to year.*
Keywords: *Efficiency, stochastic frontier analysis, Non-life insurance*

I. Introduction

Insurance is a socio economic device of risk management in which the insured transfers the cost of potential loss to another entity known as insurer against a payment known as the premium. Non-life insurance comprises of insuring property (homes, auto, etc.,) against fire and burglary, floods, storms, earthquakes and so on. It covers property insurance, health insurance, liability insurance which guards legal liabilities etc. This work aims to measure the relative efficiency of non-life insurance companies in India using Stochastic Frontier analysis. The main objectives are to measure the relative efficiency of performance for the non-life insurance industry, identify the most efficient non-life insurance companies based on relative efficiency scores, analyse the comparative technical efficiency of non-life insurance companies. This study aids insurance companies in making decision making and improving the performance, such as formulating business strategy or marketing strategy to acquire or retain customers. This study can also be used as a benchmark in determining the efficiency of insurance companies in India.

II. An Overview Of Non-Life Insurance Companies In India

Insurance in India used to be strictly regulated and monopolised by state-run insurers. After the move towards economic change in the early 1990s and the Malhotra committee in 1993 made reforms in the insurance sector and finally resulted in the formation of the Insurance Regulatory and Development Authority (IRDA) Act of 1999 which is brining the changes in insurance sector. The major duty of IRDA is to protect the policyholder's interest and suggest improvements and new ideas for growth of insurance sector. As per the Malhotra committee's recommendations, private parties are allowed to start insurance companies in India. Insurance market of India opened to foreign companies with a cap on the shareholding at 26% in the joint venture with Indian companies. The following table lists the non life insurers in India:

NON-LIFE INSURERS*

	Public Sector		Private Sector
1	National Insurance Co. Ltd.	1	Bajaj Allianz General Insurance Co. Ltd.
2	The New India Assurance Co. Ltd.	2	Bharti AXA General Insurance Co. Ltd.
3	Oriental Insurance Co. Ltd.	3	Cholamandalam MS General Insurance Co. Ltd
4	United India Insurance Co. Ltd.	4	Future Generali India Insurance Co. Ltd.
		5	HDFC ERGO General Insurance Co. Ltd.
	Specialised Insurers	6	ICICI Lombard General Insurance Co. Ltd.
5	Agriculture Insurance Co. Ltd.	7	IFFCO Tokio General Insurance Co. Ltd.
6	Export Credit Guarantee Corporation Ltd.	8	L & T General Insurance Co. Ltd
		9	Liberty Videocon General Insurance Co. Ltd.
		10	Magma HDI General Insurance Co. Ltd.
		11	Raheja QBE General Insurance Co. Ltd.
		12	Reliance General Insurance Co. Ltd.
		13	Royal Sundaram Alliance Insurance Co. Ltd.
		14	SBI General Insurance Co. Ltd.
		15	Shriram General Insurance Co. Ltd.
		16	TATA AIG General Insurance Co. Ltd.
		17	Universal Sompo General Insurance Co. Ltd.
			Standalone Health Insurers
		18	Apollo Munich Health Insurance Co. Ltd.
		19	Max Bupa Health Insurance Co. Ltd.
		20	Religare Health Insurance Co. Ltd.
		21	Star Health and Allied Insurance Co. Ltd.

RE – INSURER*
General Insurance Corporation of India

*From IRDA Annual Report 2012-13

III. Literature Review

Fetcher et al. (1993) used the Stochastic Frontier Analysis (SFA) to analyze the cost and efficiency of insurance companies in France using data from 1984 to 1989. The average level of efficiency for life insurance is 30% and general insurance is 50% are the major findings from this study. Greene and Segal (2004) found the relationship between cost inefficiency and profit for the life insurance industry in the USA. Profit is important for an insurance company because of capital gains and it determines the potential of an organization. Further they distinguish the cost of efficiency using SFA. They have stated that the cost efficiency in the life insurance industry will be strong when there is turnover and inefficiency occurs when the gain is measured by return on equity.

Fenn et al. (2007) used SFA to estimate Flexible Fourier cost and profit functions for European insurance companies with maximum likelihood. Separate frontiers are estimated for life, non-life and composites companies and use data set of financial reports for the period 1995 to 2001 and state that the larger firms and with high market shares tend to have more cost inefficiency but less of profit inefficiency.

Kasman and Turgutlu (2007) studied the technical efficiency of a sample of Turkish life insurance firms using the deterministic data envelopment analysis (DEA), chance-constrained data envelopment analysis (CCDEA) and stochastic frontier analysis (SFA) for the time period 1999 to 2005. The main purpose was to provide new insights on the effect of methodological choice on the estimated efficiency by applying econometric and mathematical programming methods to the same data set of Turkish life insurance firms. The empirical results show that the parametric and non-parametric methods provide similar rankings of firms but they differ significantly when the mean efficiency scores are considered. From the findings suggest that the stochastic structure of the CCDEA approach does not eliminate the basic differences between DEA and SFA. From the result, the three techniques suggest that there is a significant inefficiency issues in the Turkish life insurance industry over the sample period. For the theoretical of stochastic frontier functions have not explicitly formulated a model to study the inefficiency effects. Empirical studies, in which the issue of the explanation of the inefficiency effects has been raised by Kalirajan 1981, 1982, 1989; Kalirajan and Flinn 1983; and Kalirajan and Shand 1989. Their studies adopted a two-stage approach. The first stage is about the specification and estimation of the stochastic frontier production function and the prediction of either the inefficiency effects or the technical efficiencies of the companies involved. The second stage of the analysis is about the specification of a regression model for either the predicted inefficiency effects or the levels of technical efficiency of the firms in terms of various explanatory variables and an additive random error. The parameters of this second-stage inefficiency model have been generally estimated by using ordinary least-squares regression.

Recently, Nawi et al (2012) discussed the efficiency of general insurance companies in Malaysia using SFA. Further they concluded that the technical inefficiency effects associated with the production of the total profits by the input of general insurance is very low. It is found that the relative efficiency for general insurance companies have been increasing from year to year.

IV. Methodology: Stochastic Frontier Model

Berger et al. (1993) and Berger and Humphrey (1997) have introduced two techniques to measure efficiency. There are several econometric (parametric approach) and linear programming (nonparametric approach) approaches. The parametric approach has the advantage of allowing noise in the measurement of inefficiency. However, the approach needs to specify the functional form for production, cost or profit. Coelli (2004) stated that the non-parametric approach is simple and easy to calculate since it does not require the specification of the functional. The method for this study is Stochastic Frontier Analysis (SFA) by using the model of Battese and Coelli (1992).

SFA is technically from economic modeling. Aigner, Lovell, and Schmidt (1977), Meeusen and van den Broeck (1977), and Battese and Cora (1977) introduced the parametric approach to estimate stochastic production frontiers. These approaches specified a parametric production function and a two-component error term. One component, reflecting the influence of many unaccountable factors on production as well as measurement error, is considered "noise" and is usually assumed to be normal. The other component describes inefficiency and is assumed to have a one-sided distribution, of which the conventional candidates include the half normal (Aigner.et.al, 1977), truncated normal (Stevenson, 1980), exponential (Meeusen and Broeck, 1977) and gamma (Greene, 1980, b; Kalirajan, 1981). Battese and Coelli (1992) assumed a traditional random error (V_{it}) and a nonnegative error term (U_{it}) representing the technical inefficiency. Here, is assumed to be independent and identically distributed, i.i.d N $(0, \sigma^2_v)$ and captures statistical noise, measurement error, and other random events (i.e., economic situations, quakes, weather, strikes and luck) that are beyond the company's control. The non-negative error term (U_{it}) captures the inefficiency and is assumed to be i.i.d as truncations at zero of the N (μ, σ^2_u). Also, it is assumed to be independent of the U_{it} . The model may be formed as follows:

$$Y_{it} = X_{it}\,\beta + (V_{it} - U_{it}) \quad i = 1,\ldots K \text{ and } t= 1\ldots.T \qquad (1)$$

where Y_{it} is output of the ith firm in the j^{th} time period; X_{it} is a K x1 vector of inputs of the firm in the j^{th} time period; β is a vector of unknown parameters; V_{it} and U_{it} are assumed to have normal and half-normal distribution, respectively.

This method can estimate the efficiency of the insurance company according to its function and not using a specific distribution function. Features found in this method are suitable for measuring the efficiency of insurance companies because it will be arranged in the most efficient level.

The model for a specific general insurance used in this study is

$$\log Y_{it} = \beta_0 + \beta_1 \log X_{1it} + \beta_2 \log X_{2it} + \beta_3 \log X_{3it} + \beta_4 \log X_{4it} + \beta_5 \log X_{5it} + (V_{it} - U_{it}) \quad (2)$$

where Y_{it} = total profits of the i^{th} company in the t^{th} time period

β_s = vector of unknown parameters to be estimated

X_{1it} = net investment income of the i^{th} company in the t^{th} time period

X_{2it} = commissions and management expenses of the i^{th} company in the t^{th} time period

X_{3it} = total liabilities and assets of the i^{th} company in the t^{th} time period

X_{4it} = annual premium of the i^{th} company in the t^{th} time period

X_{5it} = net incurred claims paid by the company of the i^{th} company in the t^{th} time period

U_{it} = non-negative random variables, associated with it technical inefficiency of total profits of companies

V_{it} = assumed to be independent and identically distributed (i.i.d) N $(0, \sigma^2_v)$ and captures statistical noise, measurement error, and other randomness.

Battese and Coelli (1992) has proposed a stochastic frontier production function for panel data on firms, in which the non-negative technical inefficiency effects are assumed to be a function of firm-speciflc variables and vary over time. The inefficiency effects are assumed to be independently distributed as truncations of normal distributions with constant variance, but means which are a linear function of observable firm-speciflc variables. The generalized likelihood-ratio test is considered for testing the null hypotheses, that the inefficiency effects are not stochastic or that they do not depend on the firm-specific variables.

The variance parameters are

$$\sigma^2 = \sigma^2_v + \sigma^2_u \quad (3)$$

The maximum-likelihood method is applied for the estimation of the parameters of the model and the prediction of the technical efficiencies of the firms over time. This method gives more satisfactory results as more efficient than the method of ordinary least squares (OLS) (Richmond, 1974). Parameters (γ) must be in the range between 0 and 1 and is given by

$$\gamma = \sigma^2_u / \sigma^2 \quad (4)$$

Given the specification of the stochastic frontier model in Equation (1), the technical efficiency of production of the firm given the level of inputs is defined as:

$$TE_i = \exp(u_i) \quad (5)$$

So that $0 \leq TE_i \leq 1$ are inversely related to technical inefficiency (Khairo and Battese, 2005). In this study, the parameter is important because it facilitates the analysis of the efficiency of general insurance companies to be studied efficiently or not. The test statistic t and t-distribution are used and the significance levels used in this study are 0.05, 0.01 and 0.1. The hypothesis of this study is as follows:

$H_0 : \gamma = 0$ which specifies that there are no technical inefficiency effects

$H_1 : \gamma > 0$ which specifies that there are technical inefficiency effects

V. Results

This study discusses about efficiency of the non - life insurance companies, where insurance company with highest efficiency score indicates is the most efficient and reflects the company's ability to maximize the input. The total number of observations from this study is 12 firms operating in India non-life insurance industry over the period 2008 to 2013; this is the phase after the economic downturn.

The results showed 1% increase from year to year in the period 2008-2013 as shown in Table 1 for non life insurance in most of the cases. This positive improvement shows that the (non life) insurance industry has been in rise after the economic downturn. Industry efficiency is 35% to 39% over the years.

Table 1: Relative Efficiency Score for Non life Insurance Companies from 2008-09 to 2012-13

Insurance Company	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	Rank
	Year1	Year2	Year3	Year4	Year 5	
BhartiAXA	0.73	0.74	0.75	0.75	0.76	1
Reliance General	0.60	0.61	0.62	0.63	0.64	2
ICICI Lombard	0.54	0.55	0.56	0.57	0.58	3
Future Generali	0.42	0.43	0.44	0.45	0.46	4
Universal Sompo	0.34	0.35	0.37	0.38		5

						0.39	
	Bajai Allianz	0.33	0.34	0.35	0.36	0.37	6
	HDFC Ergo	0.30	0.31	0.32	0.34	0.35	7
	Tata AIG	0.24	0.25	0.26	0.27	0.29	8
	IFFICO Tokio	0.23	0.24	0.25	0.26	0.28	9
	CholamandalamMS	0.17	0.18	0.19	0.20	0.21	10
	Royal Sundaram	0.17	0.18	0.19	0.20	0.21	11
	ShriRam General	0.11	0.12	0.12	0.13	0.14	12
Mean Efficiency		**0.35**	**0.36**	**0.37**	**0.38**	**0.39**	

Table 2: Results of Maximum Likelihood Estimation for the Non Life Insurance Industry

parameters	coefficient	standard-error	t-ratio
β_0	5.2447	0.7274	7.2102*
β_1	0.4518	0.0730	6.1875*
β_2	(0.3705)	0.1964	(1.8863)***
β_3	(0.0094)	0.0466	(0.2020)
β_4	0.4357	0.1981	2.1996*
β_5	(0.1181)	0.1434	(0.8235)
σ^2	0.2793	0.0828	3.3750*
γ	0.9251	0.0336	27.4947*
μ	1.0166	0.7187	1.4145
η	0.0310	0.0185	1.6773***

Log likelihood function = 6.169 ; Significance levels used in this study are 0.05* ,0.01**and 0.1***

Table 2 presents the maximum likelihood estimate (MLE) for the parameters of the linear productions function and related statistical tests results obtained from the stochastic frontier analysis. The value in brackets denotes negative value. The estimated σ^2 in this study is 0.2793 and is statistically significant and different from zero. The result indicates that the one-sided error term dominates the symmetry error indicating a good fit and the correctness of the specified distributional assumptions. The significant value of γ indicates that significant relationship between net investment income, commissions and management expenses, total liabilities and assets, annual premium and net incurred claims paid by company. The 0.9251 value for the variance γ parameter in this study is near to one, suggesting that all of the residual variations are due to the inefficiency effects. The technical inefficiency effects having a half-normal distribution, is tested by the null hypothesis H_0: $\mu=0$. In this study, this hypothesis is accepted which indicates that the half normal distribution is suitable for the technical inefficiency effect. The hypothesis H_0: $\eta=0$ is rejected and it is found that the η component assumes positive sign and is significant at 0.1 level indicating that the technical inefficiency effect varies significantly over time. Thus, technical inefficiency is decreasing over time for the analyzed sample. It is important to highlight that **η** is unique for the sample analyzed. Results of maximum likelihood estimation (MLE) found that the elasticity of the total profits for annual premium is the highest 0.4357. This means that with an increase 1% in input annual premium will increase by 0.4357% on the profitability of companies. For the input of the investment income, the elasticity of the total profit is 0.4578. This means that 1% increase in investment income input resulted in an increase of 0.4578% on the profitability of general insurance companies.

The result showed that Bharti AXA is at rank 1 and it has a relative efficiency score higher than most other companies. Score for the second position and third position are Reliance General and ICICI Lombard.

Mean of efficiency score of non life insurance companies were increasing by 1% from year to year as presented in Table 1. No company is fully efficient, showing issues in managing the company's management expenses, liabilities and controlling claims payout.

VI. Conclusion

This study focuses on stochastic frontier analysis approach (SFA) that involves econometric methods used to analyze the efficiency of non-life insurance companies in India for the period 2008 - 2013. We have observed that the estimated values of the time-varying inefficiency parameter η are positive for the half normal distribution. These indicate that technical inefficiency has declined over the period selected. Thus, the relative

efficiency for non- life insurance companies have been increasing from year to year. Tests for different null hypotheses involved in the stochastic frontier model showed that the technical inefficiency effects for the selected private non-life insurance firms industries in India are significant. It has been found that the mean efficiency over the period is increased from 35% to 39% over the years. But, the rate of increase in technical efficiency has been very slow over. From the results, found that BhartiAXA is at rank 1 and it has a relative efficiency score higher than most other companies. Score for the second position and third position are Reliance General and ICICI Lombard. In addition, the efficiency performance of the general insurance industry increased by an increase of 0.01(1%) by every year after the economic downturn. According to the rank of efficiency included in this study can help people in selecting and evaluating non life insurance companies that have good performance. This study also will help the management and administration of insurance firms involved in making and improves the weaknesses, such as formulating business strategy or marketing strategy to attract and retain the customers. This study can also be used as a benchmark in determining the efficiency of insurance companies in India as appropriate.

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