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Performance Appraisal of Indian Non-Life Insurance Companies: A DEA Approach

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Abstract The aim of the study was to measure the efficiency of non life insurance companies operating in India. For this purpose 20 non life insurance companies were selected for the financial year period 2012-13. Data envelopment analysis (DEA) technique was applied to assess the efficiency scores of the insurers. OLS regression method was used in conjunction with financial ratios to ascertain the exposure they have on the overall technical efficiency (OTE) of the insurers. Thus, the results showed directional impact the ratios have on the technical efficiency of the insurers.

Keywords Technical Efficiency, Pure Technical Efficiency, Scale Efficiency

JEL Classification: C30, C61, G22

1. Introduction

Efficiency measurement is becoming a very vital component in the contemporary business environment. Companies are becoming cautious to their productivity and thus consciously putting emphasis on evaluating their performance levels. A company is deemed to be efficient if it optimally utilizes its resources i.e. inputs in producing the output and inefficient if vice versa.

Non-life insurance segment has been regarded as one of the burgeoning sectors in the financial services sphere in India. A consistent growth in terms of business size and premium has been registered by this sector over a decade.

Many companies have roped into this industry which has germinated intense competition in the sector. Due to the high risky nature of this industry, need to analyze the performance of the non-life insurer is immensely critical. Thus efficiency measurement is viewed as a coherent aspect of the business performance analyses.

In latter sections will be discussing about the inputs and outputs variables for measuring performance of the non-life insurers.

1.1. Brief Overview on India's Non-Life Insurance Sector

Year of 1999 is marked as an era of liberalisation for insurance sector in India. During this period private companies were allowed to venture into the insurance business which in past remained at the hands of public companies. Presently there are four public and twenty three private non-life insurance companies operating in the non-life geographies of India.

Enormous change in the functioning of this sector been observed after the opening up of this sector. Several new products and services were launched in the market by the insurers. Huge manpower and capital were being employed to manage the operations.

Being a regulated industry, every company has to strictly comply with the guidelines and provision as laid down by the regulator (IRDA) for conducting their business operations. Thus eliciting the need for more monitoring and assessing 'how' efficiently they can manage their customers, company along with meeting the regulators defined provisions.

On this background, it became significant to examine the relative efficiency of each individual insurer. So to plumb deeply into the areas which an insurers need to improve for their efficiency levels were explored. Also search for reasons, whether the inefficiency is due to managerial underperformance or due to inappropriate scale size were cross examined. The current study in specific terms would measure the technical, pure technical and scale efficiency of individual insurers using two stage data analysis model.

In the first stage, methodological framework, technical, pure technical and scale efficiencies will be obtained by employing the two well known models developed by Charnes, Cooper and Rhodes (CCR) and Banker, Charnes and Cooper (BCC) under Data envelopment analysis (DEA). In the second stage the overall technical efficiency obtained in the first stage will be regressed on the exogenous factors. These exogenous factors will depict the direction and influence these factors have on the efficiency level of the insurers.

But before moving ahead, few concepts need some elaboration like technical, pure technical and scale efficiency. A unit is referred to as technically efficient if its inputs are productively utilized. Technical efficiency is a comparative measure of how well it actually processes inputs

to achieve its outputs, as compared to its maximum potential for doing so, as represented by its production possibility frontier (Barros and Mascarenhas, 2005)(Kumar and Gulati, 2008). So an insurer would be stated as technically efficient if it optimally transforms its resources into multiple services. An insurer would be regarded as technically inefficient if it operates below the efficient frontier. In DEA, technical efficiency is bisulcated into two components: pure technical efficiency and scale efficiency. The pure technical efficiency is used as an index to capture managerial performance (Kumar and Gulati, 2008). On the other side, scale efficiency measures the optimum size the management should adopt to produce an expected level of production. Thus inappropriate size of an insurer could result into scale inefficiency. The concept of scale of economies in pure economic term would be appropriate to define the scale efficiency.

2. Literature Review on the Efficiency

Many empirical studies had undergone in assessing the efficiencies of insurance companies, but largely the sphere of research was limited to the overseas insurance companies and markets. Only few works have been tendered in this arena for efficiency measurement of insurance companies in India. The idea for the present study has been derived from the past studies done by Berger, 1997; Cummins, Weiss and Berger, 1997; Yugengert, 1993; Cummins et al., 1999; Diacon et al., 2002; Feroz et al., 2003 etc. Most of these studies in particular evaluated the companies using the Data envelopment technique (DEA) and some supplemented the results in conjunction with the company's financial ratios. A summary of the previous studies are exhibited in the Table1.

2.1. Objective of the Study

The main objective of the study was to assess the overall technical efficiency of the 20 non-life insurer operating in India. To assess how much reduction in the input units required to make the inefficient insurers operate efficiently. Lastly to examine the impact of the financial ratios have on the efficiency level of the company.

Table 1. Summary Sheet of Previous Research

Authors	Method	Units	Inputs	Outputs
Gardner and Grace ,1993	Cobb-Douglas Frontier	561 life insurance companies in USA, 1985-1990	Labour, Capital and Miscellaneous items.	Ordinary life insurance premium, group, life insurance premiums, ordinary annuity, group annuity, group accident and health premium
Cummins et al., 1996	DEA and Malmquist index	17 Italian life, 58 non-life and 19 mixed insurance companies, 1985-1993	Wages, administrative wages, fixed capital, equity capital and other ratios	Life insurance benefits and changes in reserves, non-life incurred losses in auto, auto liability and invested assets.
Fukuyama, 1997	DEA and Malmquist index	25 Japanese life insurance companies, 1988-1993	Asset value, number of workers and tied agents or sales representatives	Insurance reserves, loans.
Cummins and Zi, 1998	DEA and Malmquist index	USA insurance companies, 1988-1992	Loan, financial capital and materials	Incurred benefits desegregated into ordinary life insurance, group life insurance and individual annuities, and reserves.
Cummins et al., 1999	DEA-input oriented and Malmquist index	USA insurers, 1981-1990	Labour cost, material, policy holders supplied debt capital and equity capital and real invested assets	Short tail personal lines, short tail commercial lines, long tail personal lines, long tail commercial lines and return on assets.
Diacon et al., 2002	DEA-CRS and DEA-VRS	Standard's and Poor's Eurothesys data base, 1996-1999	Total operating expenses, net reinsurance commissions, total capital, total technical reserves and total borrowings	General Insurance net earned premiums, long term insurance net earned premium, total investment income.
Mahlberg and Url, 2003	DEA and Malmquist index	Austrian insurance companies, 1992-1999	Administration and distribution cost and costs of capital investments	Aggregate value of: expenditure on claims incurred, net change in technical provisions and the amount of returned premiums desegregated on health insurance, life insurance, property-liability insurance.
Barros et al.,	DEA and truncated bootstrapped regression	71 insurance companies, 17 life, 41 non-life and 10 mixed, 1994-2003	Labour cost, non labour cost and equity capital	Invested assets, losses incurred, reinsurance reserves and own reserves.

Sources: Authors' summarization

3. Methodological Framework

For analyzing the performance of the non-life insurers in India selection of the insurer was the done on the basis of structural homogeneity. The insurer with similar set up, product and services, and operating provisions were chosen for the study. From twenty seven non life insurers, twenty insurers were selected i.e. the minimum number of DMU's were greater than three times the number of inputs plus outputs (Vassilogou and Giokas, 1990). (M Vassiloglou, A study of the relative efficiency of banks branches: An application of data envelopment analysis, 1990) Of them, four were public insurers and sixteen were private insurers. The period selected was from the financial year April 2012 to March 2013. The insurers which have completed twelve months of their business operations in the year selected were included in the study.

3.1. Specification of Data and Variable

For the purpose of conducting this research selection of variables was a sensitive task. The selection was performed stage wise. In the stage one, inputs and outputs for conducting the efficiency measurement were selected. On the stage two, exogenous variables i.e. financial ratios were selected to perform the analysis.

3.2. Inputs and Outputs Selection- for DEA Model

For ascertaining the efficiency, selection of inputs and outputs becomes a complex task. There are no fixed inputs and output variables that are obligated to be used for ascertainment of the efficiency scores. In general inputs such as land, labour and capital are utilized to product a firm's output, so acquisition of these inputs represents a cost. Outputs, on the other hand represent the goods/services which a customer prepares to purchase and whose sale generates revenue for the firm. Cooper, Seiford and Tone (2000) have commented that DMU's should generally prefer smaller input and larger outputs, and this relationship should be reflected in the efficiency scores. The management of the DMU should be able to control either the inputs or outputs in order to improve efficiency.

As set by Diacon et al., (2002), this study used proxies for land, labour and capital as management expenses, commission expenses and shareholder's capital as the inputs. Whereas, net premium and income from investments chosen as the output.

Table 2. Input and Output Variable

Inputs	Outputs
Commission, Management Expenses, Shareholder Capital	Net Premium, Income from Investments

3.3. Exogenous Variables for Estimating the Effects on OTE

To discover the impact of external factors those affecting the efficiency of the companies' five prominent financial ratios pertaining to insurer economic health were considered for determining their effect on the efficiency levels of the insurers. The ratio/factors are shown in the Table 3.

Certain possible generalization were formed to see the direction that financial ratio indicates for the efficiency level. Technical reserve ratio, Net earnings ratio and Liquid asset to liability ratio shows a positive effect on the efficiency of the firm whereas high Management expense ratio and high Combined ratio negatively affect the overall efficiency of the firm. The expected possibilities are denoted by '+ve' and '-ve' signs in the column.

Table 3. Predictors Description and the Expected Sign

Predictor	Symbol	Description	Expected Sign
Technical Reserve ratio	TRR	$\frac{Reserve\ for\ Unexpired + Out.Claims}{Net\ Premium}\ X\ 100$	+
Management Exp Ratio	MER	$\frac{Expense\ of\ Management}{Gross\ Direct\ Written\ Premium}\ X\ 100$	-
Net Earnings Ratio	NER	$\frac{Profit\ after\ Tax}{Net\ Premium}\ X\ 100$	+
Liquid Asset to Liability Ratio	LALR	$\frac{Liquid\ Asset}{Policyholders'\ Liability}\ X\ 100$	+
Combined Ratio	CBR	$\frac{Claims + Management\ Exp}{Gross\ Direct\ Written\ Premium}\ X\ 100$	-

Source: Authors' Creation

3.4. The DEA Model – Stage One Analysis

DEA is a mathematical programming technique which is used to assess the relative efficiency of different DMU's (in study, the insurers) using several input and output data. The term 'relative' signifies that a DMU which is identified as efficient by DEA of a given data set may be deemed to be as inefficient when compared with another DMU's with another set of data. In simple terms a comparison is carried among the DMU's. So a relative ratio is determined by building a ratio of total weighted outputs to total weighted inputs for each DMU. The most efficient DMU's forms the efficient frontier and the DMU's lying away from the frontier considered to be as inefficient DMU's. An advantage of DEA is that it uses actual sample data to derive the efficiency frontier against which each unit in the sample is evaluated with no a priori information regarding which inputs and outputs are the most important in the evaluation procedure (Yeh, 1996).

The model is described as under:-

$$Max\ e^o = \sum_{j=1}^{j} u_j^o\, y_j^o \,/\, \sum_{I=1}^{I} v_i^o\, x_i^o \qquad (1)$$

Subject to,

$$\sum_{j=1}^{j} u_j^o\, y_j^n \,/ \sum_{I=1}^{I} v_i^o\, x_i^n \le 1$$

n= 1,……N

$u_j^o, v_i^o \ge 0$ i = 1……..,. l ; j=1,…..,. J.

Here y_j^n, x_i^n are positive outputs and inputs of the nth DMU and u_j^o , v_i^o are variable weights that would be determined by solving the problem. The DMU being been measured is indicated by the index O, which forms to be the base DMU. The objective function for the base DMU is defined as e^o, which referred to as the efficiency score that has to be determined. If $e^o = 1$ then the DMU in the base function is deemed as efficient DMU otherwise it is inefficient.

To ascertain the weights (u, v) in the equation (1), Charnes, Cooper and Rhodes (CCR) transformed this problem from fractional into a linear form. It is as follows,

$$Max\ h^o = \sum_{j=1}^{j} u_j^o\, y_j^o \qquad (2)$$

Subject to,

$$\sum_{I=1}^{I} v_i^o\, x_i^o = 1$$

$$\sum_{j=1}^{j} u_j^o\, y_j^n - \sum_{I=1}^{I} v_i^o\, x_i^n \le 0; \qquad n = 1\ldots\ldots \mathrm{N},$$

$u_j^o \ge \varepsilon;\ v_i^o \ge \varepsilon;$ i= 1……..,. I ; j=1,…..,. J.

In both the equation (1) and (2) the variables defined are the same. Only a small positive number ε is placed in the equation (2) for ensuring that both the inputs and outputs weights have positive values and the optimal objective function of the dual problem in equation (2) is not affected by the values assigned to the dual slack variables while computing the DEA efficiency score for each DMU (Yeh,1996). The parameter set as $h^o = 1$ states that DMU (o) is DEA efficient; otherwise it is DEA inefficient among the all other DMU's in the study. For obtaining the efficiency score, the DEA model is required to be iterated N times generating diverse efficiency scores for each DMU with N different (u_j^o, v_i^o) weights sets.

The model defined by Charnes et al. was based on the assumption of constant returns to scale, meaning that all the production combinations being applied can be only be scaled up or down in proportion, implying no economies or diseconomies of scales. But in real premise the assumption doesn't hold fit. As for any insurer increase in inputs will result three possible situations on its output levels viz (1) its output will increase in linearity with the input, a constant returns to scale (2) its output increases more than the input vested, an increasing return to scale (3) its output increases less than the increase in the inputs, a decreasing returns to scale.

To encounter this, Bankers, Charnes and Cooper (BCC) proposed a slight modification in the CCR model. For estimating the pure technical efficiency and scale efficiency we followed the input oriented BCC model for our study. Since the basic objective was to probe into the operational functioning of the insurer and to figure out the cause for their inefficiencies. The input oriented variable returns to scale BCC model is as:

$$Max\ h^o = \sum_{j=1}^{j} u_j^o\, y_j^o + w_o \qquad (3)$$

Subject to,

$$\sum_{I=1}^{I} v_i^o\, x_i^o = 1$$

$$\sum_{j=1}^{j} u_j^o\, y_j^n - \sum_{I=1}^{I} v_i^o\, x_i^n + w_o \le 0; \qquad n = 1\ldots\ldots \mathrm{N},$$

$$u_j^o \ge \varepsilon;\ v_i^o \ge \varepsilon;$$

i= 1……..,. I ; j=1,…..,. J.

w_o *is unconstrained in sign*

Here, ε is a small positive number. The value of $w_o > 0$ implies increasing returns to scale, $w_0 < 0$ implies decreasing returns to scale and $w_o = 0$ implies constant returns to scale. Hence the BCC model allots two individual efficiency measures in form of pure technical and scale for each insurer. This let an ease in determining whether the insurer are operating on the zone of increasing, decreasing or constant returns to scale.

The linear programming model (3) was executed 20 times for obtaining the technical efficiency for all insurers in the sample. The weights for each inputs and outputs were defaultly assigned by the DEA.

Finally for application of the DEA model a meaningful selection of input-output combination is required. The data

points selected should be uniform in data sets. It should be non negative in unit. Since DEA is a relative efficiency measure so if the sample selected is large then better contrast it may provide in the results. So, larger the sample unit selected reliable will be the outcome for the units.

3.5. Second Stage Analysis- Exogenous Variables Effect on Overall Technical Efficiency

As a research framework, the second stage analysis was performed to translate the effects of exogenous variables have on the overall technical efficiency of the insurer's. These exogenous variables are the insurer's financial ratios. Too see the impact of these sets of ratios on the efficiency of the insurers were analysed. For the purpose of interpretation, the direction of each financial ratio was preferred and selected. To ascertain the effects, a linear regression function model was formed:

$$y = \alpha + \beta 1\, X1 + \beta 2X2 + \ldots \ldots \beta niXni \qquad (1)$$

Where;
y = overall technical efficiency score;
β = (slope) coefficient for the independent variables;
X_i= Financial ratios of the insurer's;
α= the intercept or the constant term;
ε_i= random error term

$$\text{OTE (score)} = \alpha + \beta_1(\text{TRR}) + \beta_2(\text{MER}) + \beta_3(\text{NER}) + \beta_4(\text{LALR}) + \beta_5(\text{CBR}) + \varepsilon_i \qquad (2)$$

The Equation (2) proposed above is an expanded form of the equation (1). The direction for each variable of the equation was captured. Positive (+) and negative (-) sign will indicated how the financial ratios affect the efficiency scores and also clarifies the objectives framed. By using this model we may also find a close relationship between financial ratios and DEA score. Signaling out that insurers operating within their limits tends to be close to efficient frontier or remain on the frontier.

4. Empirical Results

The Table 4 shows the efficiency score for each insurer. The efficiency score were obtained from the input -oriented model (BCC). It shows 'by how much' an insurer should reduce their inputs without changing their outputs so as to be on the efficient frontier. There were 20 insurer's in the analysis; of them only 7 were found as overall technically efficient and rest 13 were found operating away from the efficient frontier. The insurer with an OTE score of 1 is held as efficient insurer. The insurers with OTE score below 1 are deemed to be relatively inefficient. The average overall technical efficiency score was found to be 73.9 per cent (see Appendix 1). This suggest that if the insurers reduces their inputs of physical capital, management expenses and commission by atleast 26.05 per cent still they could manage to produce the existing level of outputs.

The range of OTE scores among all the insurers were found broadly within 11.91 per cent to 100 per cent. It was discovered that of the four public non-life insurers only one was witnessed as *efficient*, rest all the three public insurers's noticed as operating inefficiently (refer Appendix 2). It was also found that all the inefficient public insurers were place below the average overall technical efficiency levels (AOTE) of 59.9 per cent (see Appendix 3) while for private non-life insurer, the AOTE score was slated at 60.80 per cent which is marginally above the average overall technical efficiency level. This reflects that public insurers are inappropriately managing their inputs, compared to the private insurers.

There are few insurers whose efficiency scores were below 50 per cent, the rationale behind this poor inefficiency score is to the fact, that these firms have commenced their business operation recently. Also it can be cerebrated from the analysis that all these insurer shown an increasing returns scale (IRS) charactertics which poses the issue of scale inefficiencies.

4.1. Discrimination of the Insurers

As showed earlier, there were seven insurers who were determined as efficient by DEA. Now these efficient insurers become the benchmark units for other inefficient unit. The DMUs with efficiency values equal to 1 are efficient insurers, so all DMUs with efficiency values of 1 can constitute a ''facet reference set". If a DMU's efficiency value is smaller than 1, it indicates that such DMU appears inefficient as compared with the 'facet reference set' and its efficiency can be improved by means of various management measures(Lin et al., 2009).

Norman and Stocker (1991) in his study proposed four criteria's by which the discrimination of the efficient and inefficient DMU's could be made. The criteria's were as follows:

(1) The Robustly efficient units;
(2) The Marginal efficient units;
(3) The Marginal inefficient units; (efficiency score >0.90 but < 1)
(4) The Distinctly inefficient units; (efficiency score < 0.90)

The insurer which appeared in many efficient facet reference set will be considered as highly efficient. From the table 5, three insurer viz. Shriram GI, Bajaj Allianz and Cholamandalam MS were discovered as 'the robustly efficient units'. The other four insurers were reified as 'the marginally efficient units'.

Only one insurer was found as marginally inefficient as its efficiency value was less than 1 but greater than 0.90. Thus rest of the insurers were shifted to the distinctly inefficient units head since there efficiency scores was found below 0.90 (refer table 5).

Table 4. Overall Technical, Pure Technical and Scale Efficiency Scores of Insurers' in India

Company Code	Company Name	OTE Score	OTIE (%)	PTE Score	PTIE (%)	SE Score	SCIE (%)	RTS
IC1	Bajaj Allianz	1.000	0.0	1.000	0.0	1.000	0.0	DRS
IC2	Bharti Axa	0.682	31.8	0.682	31.8	0.997	0.003	IRS
IC3	Cholamandalam MS	1.000	0.0	1.000	0.0	1.000	0.0	CRS
IC4	Future Generali	0.872	12.8	0.874	12.6	0.997	0.3	IRS
IC5	HDFC ERGO	0.596	40.4	0.636	36.4	0.936	6.7	IRS
IC6	ICICI Lombard	1.000	0.0	1.000	0.0	1.000	0.0	DRS
IC7	Iffco Tokio	0.797	20.3	0.853	14.7	0.933	6.7	IRS
IC8	L & T Insurance	0.249	75.1	0.551	44.9	0.452	54.2	IRS
IC9	National Insurance	1.000	0.0	1.000	0.0	1.000	0.0	CRS
IC10	New India	0.576	42.4	1.000	0.0	0.576	42.4	DRS
IC11	Reliance Gen	1.000	0.0	1.000	0.0	1.000	0.0	CRS
IC12	Royal Sundaram	0.929	7.1	1.000	0.0	0.929	7.10	IRS
IC13	Tata AIG	0.755	24.5	0.823	17.7	0.917	8.3	IRS
IC14	United India	0.594	40.6	1.000	0.0	0.594	40.6	DRS
IC15	Universal Sumpo	0.878	12.2	1.000	0.0	0.878	12.2	IRS
IC16	Oriental	0.535	46.5	0.835	16.5	0.640	36.0	DRS
IC17	SBI General	0.204	79.6	0.429	57.1	0.475	52.5	IRS
IC18	Shriram General	1.000	0.0	1.000	0.0	1.000	0.0	CRS
IC19	Raheja QBE	1.000	0.0	1.000	0.0	1.000	0.0	IRS
IC20	Magma HDI	0.119	88.1	1.000	0.0	0.119	88.1	IRS

OTE=Overall Technical efficiency, OTIE%=Overall Technical Inefficiency (1-OTE)X100, PTE=Pure Technical Efficiency, PTIE%=Pure Technical Inefficiency(1-PTE)X100, SE=Scale Efficiency, SCIE%=Scale Inefficiency(1-SCIE)X100, RTS=Returns to Scale, DRS=Decreasing Returns to Scale, CRS=Constant Returns to Scale, IRS=Increasing Returns to Scale

Source: Authors' estimates

Table 5. Summary for Discriminate Units

Efficient Units		Inefficient Units	
Robustly Efficient Unit	Marginally Efficient Unit	Marginally Inefficient Units	Distinctly Inefficient Units
Shriram GI (IC18) Bajaj Allianz (IC1) Cholamandalam MS (IC3)	ICICI Lombard (IC6) National Insurance (IC9) Reliance GI (IC11) Raheja QBE (IC19)	Royal Sundaram (IC12)	Universal Sumpo (IC15) Future Generali (IC4) Iffco Tokio (IC7) Tata AIG (IC13) Bharti Axa (IC2) HDFC ERGO (IC5) United India IC14) New India (IC10) Oriental (IC16) L & T Insurance (IC8) SBI General (IC17) Magma HDI (IC20)

(A)Based on the frequency of unit in the facets reference units column; (B) The order for the insurer were based on the range as ≤0.90 *Marginally inefficient units ; Below 0.90 Distinctly inefficient units.*

Source: Authors creation.

4.2. Pure Technical Efficiency and Scale Efficiency of the Insurers

For analyzing per se, it becomes imperative to understand the terms pure technical efficiency and scale efficiency with relation to the insurers. As noted earlier that technical efficiency measure corresponding to constant returns to scale (CRS) assumption represents overall technical efficiency (OTE) which assesses the inefficiency due to the input and output configuration and as well as the size of operations. The efficiency measured under the variable returns scale (VRS) represents the pure technical efficiency (PTE) which directly results from the managerial performance of the insurer by appropriately organizing the inputs. Scale efficiency represents the relationship between PTE and OTE (SE= OTE/PTE) measures. The scale inefficiency happens when the insurers operates at an inappropriate size (either too large or too small). Hence there may be situation when an insurers operating with OTE score of 1 but it might operates at decreasing returns to scale (DRS) or increasing returns to scale (IRS) which represents they are operating at an inappropriate size. Under the given state it becomes essential for the insurers to either reduce or increase their size of operation to contain their efficiency level at unity.

It can be interpreted from the Table 4 that of the 20 insurers, 5 insurers were operating at the zone of DRS; thus downsizing remains a viable strategic alternative for these set of insurers. On the other hand 11 insurers were operating on the zone of IRS; hence scaling up their size of operation would enhance their overall technical efficiency levels. Rest 4 insurer were operating at the most productive and appropriate scale size and hence experiencing a constant return to scale. On the whole, increasing return to scale is found virtually the paramount form of scale inefficiency in the Indian insurance industry.

4.3. Improvement Areas: Slack Variable Analysis

After obtaining the efficiency scores for each insurer, next step comes to determine the areas of improvement for each inefficient insurer. To ascertain it, slack variable analysis was performed. The slack variable analysis was performed for only inefficient insurers. It provides information with respect to areas which an inefficient insurer needs to improve and by *how* much unit. In simple terms, slacks are the left over values for each inefficient insurer. The input slack represents value of excess input used while output slack exemplifies output that is under produced.

It can be traced that of the 13 inefficient insurers, 3 insurers were holding a non-zero slack for net commission, 2 for management expenses and 8 for shareholder capital in case of input Appendix 5). This affirms that insurer needs to reduce the employment of shareholders capital and need to augment the income from the investment to transmute them to the efficient frontier. So on whole, the insurers ought to place a veracious operating strategy to manage their input and output effectively to conduct their business operation.

(Appendix 8) dipicts the target values of inputs and outputs for each inefficient insurers with potential accretion in outputs and reduction in inputs. The implication of potential improvement on the input and output activity will place the inefficient insurer on the efficient frontier. To construe basic idea, let's consider the case of Royal Sundaram which is only a marginally inefficient insurer in the sample. For moving itself onto the efficient frontier, Royal Sundaram needs to reduce its commission input by 7.03 per cent, cut management expenses by 23.93 per cent, utilize 7.03 per cent less of the shareholder capital and increase the income from investments by 53.32 per cent.

5. Exogenous Variables Effect on OTE: Second Stage Analysis

Table 6 reports the results for the multiple regression analysis applied to observe the direction of each exogenous variable and their individual effect on the overall technical efficiency of the insurers. It can be interpreted from the table the model is overall fit with $F\ value = 7.975$ at $p \leq 0.001$. The adjusted R^2 is found to be 0.647 which indicates that 64 per cent of the variation is explained by the predictors in the model about whether the insurer is or not efficient. It is also noticed that of the five predictor variables forming the part of the model, four turned out to be individually significant statistically leaving one predictor (CBR) as insignificant in the sample.

Looking at coefficient values of each exogenous variable, TRR and NER reflected a positive impact on the overall technical efficiency (OTE) whereas LALR, MER and CBR affects negatively to the dependent variable. As putted in the beginning the expected sign for each of these exogenous variable, we can make out only one variable i.e. LALR is showing an opposite sign as presumed earlier. After introspecting deeply, it was found that majority of the insurer have been experiencing trouble in meeting their short term liabilities. Short term liability forms from the outstanding policyholder's claims payment, so it was detected that surge in the frequency of claims in the year of examination was high which has ultimately resulted into an issue of working capital management. Hence, higher the liabilities than assets of an insurer, negative impact it may cause on the operating efficiency of their businesses.

MER and CBR appeared as anticipated, MER i.e. the management expenses has an inverse effect on the overall technical efficiency score. Similarly CBR (combined ratio) also affect negatively to outcome variable but was found statistically insignificant in the course of the study.

So we can cogitate from the regression estimates that the predictor variables in the model do show a directional effect over the overall technical scores (OTE). In addition, it can be said higher the TRR and NER, healthier would be the operational efficiency of the insurers. As one reflects the part of capital and other represents the profitability for the insurers.

Table 6. Results for Multiple Regression Analysis

	Coefficient	Std Error	*t* value	*P* value
Constant	1.1305	0.458	2.468	0.027**
TRR	0.285	0.089	3.219	0.006***
NER	0.760	0.294	2.587	0.022**
LALR	-0.147	0.052	-2.819	0.014**
MER	-2.032	0.962	-2.112	0.053*
CBR	-0.118	0.198	-0.594	0.562
F value	7.975			
R value	0.860			
R^2 value	0.740			
Adjusted R^2 value	0.647			
Sig	0.001***			

*p≤ 0.01***; p ≤0.05**; p≤0.10* dipicts the level of significance. Outcome variable = Overall Technical efficiency score for each insurer.TRR=Technical reserve ratio; NER=Net earnings ratio; LALR=Liquid asset and Liability ratio; CBR=Combined ratio*

Source: Authors' Estimate

6. Conclusions

In this paper, we analysed the overall technical efficiency, pure technical efficiency and scale efficiency for each insurer for the financial period of 2012-2013. It was observed, of the 20 insurers in the study only 7 were found completely efficient as derived from overall technical efficiency scores. This shows that these insurers were employing their inputs effectively and judiciously in producing the existing level of output. While on the other side, 13 insurers were reported as inefficient as they were operating below the *efficient frontier*. It highlighted the issue of inappropriate management and control of the inputs by them.

The main cause detected for the inefficiency of the insurers was primarily due to the scale inefficiencies. It was figured that largely the insurers were operating on an inappropriate productive scale size. It was noticed that 50 per cent of the insurer were operating at an increasing returns to scale hence for them it is required to scale up their size of operation to become efficient.

From the second stage analysis it was found that technical reserve and net earnings positively affects the overall technical efficiency. So for the insurers in the sample it becomes critical to soundly manage their technical reserves and keep a close check on their net earnings also referred to as bottom line in business. Similarly the results also showed that management expenses have a negative impact on the overall technical efficiency of the insurers. Thus it pronounces to insurers, to restrain themselves from any unwarranted spending and prudently expend money on their operating activities. Lastly, it was traced from the study that there was only one insurer whose LALR was over the desired limits of the adequacy margin, barring it, rest of the insurers were experiencing lower ratios. So it unfolds the issue of working capital management for every insurer in the sample which presumably has been overlooked completely by the insurer. To overcome this hurdle, insurers need to cautiously underwrite the risks and avoid the risks which have an extreme probability to occur and incur losses.

In general, the inputs and outputs chosen for evaluating the performance of each insurer had provided some critical and useful information about their operating performance. Though their still exist several limitations to the study, but, it may display and provide some warning signals to insurers especially in the discourse of managing their working capital, so that they may redesign their management strategy and work on to improve on their efficiency level. Lastly it creates an ample scope for researchers to investigate and examine further into this sector and suggest avenues which in course need improvement and attention.

Appendix 1. Descriptive Statistics for All Non-Life Insurer's of Overall Technical Efficiency Score

Statistics	All Insurers	Efficient Insurers	Inefficient Insurers
N	20	7	13
AOTE	0.739	1.000	0.599
SD	0.288	0	0.265
Minimum	0.119	1	0.119
Q1	0.580	1	0.392
Median	0.834	1	0.596
Q3	1.000	1	0.834
AOTIE (%)	26.05	0	40.1
Interval	(0.451; 1.02)		(0.334; 0.864)
Notes: AOTE=Average Technical Efficiency Score; SD= Standard Deviation; Q1=First Quartile; Q3=Third Quartile; AOTIE(%)=Percentage of Average Overall Technical inefficiency(1-AOTE)X100; Interval {AOTE-SD; AOTE+SD}			

Source: Authors' Estimate

Appendix 2. Descriptive Statistics of Public and Private Non-Life Insurer's for Overall Technical Efficiency Score

Statistics	Inefficient Public Insurers	Inefficient Private Insurers
Number of Insurer	3	10
Average OTE	0.568	0.608
Standard Deviation	0.030	0.305
Minimum	0.535	0.119
Q1	0.535	0.238
Median	0.576	0.718
Q3	0.594	0.873
Average OTIE (%)	43.13	39.17
Interval	(0.538 ; 0.5989)	(0.3029 ; 0.9137)
Notes: AOTE=Average Technical Efficiency Score; SD= Standard Deviation; Q1=First Quartile; Q3=Third Quartile; AOTIE(%)=Percentage of Average Overall Technical inefficiency(1-AOTE)X100; Interval {AOTE-SD; AOTE+SD}		

Source: Authors' Estimate

Appendix 3. Reference Sets for Inefficient Insurers

Company Code	Company Name	Bajaj Allianz	Cholamandalam MS	ICICI Lombard	National Insurance	Reliance GI	Shriram GI	Raheja QBE
IC2	Bharti Axa		0.6996				0.0690	
IC4	Future Generali	0.0210	0.5944				0.0510	
IC5	HDFC ERGO	0.0101			0.0917		0.5204	
IC7	Iffco Tokio		0.2319		0.1618		0.0545	
IC8	L&T Insurance		0.0791				0.0270	
IC10	New India			0.5481		3.1279	2.4668	
IC12	Royal Sundaram		0.1282		0.1461			
IC13	Tata AIG				0.1858			
IC14	United India			0.2178			5.2199	
IC15	Universal Sumpo			0.0021		0.2143	0.0065	
IC16	Oriental Insurance	0.5988	0.0756				3.3496	
IC17	SBI General	0.0130		0.0276			0.0710	
IC20	Magma HDI	0.0026		0.0014				0.0083
Frequency Count		6	6	5	4	2	10	1

Source: Authors Estimates

Appendix.4. Slack Values for Inefficient Insurers

Company Code	Company Name	Net Commission	Management Exp	Shareholders Capital	Net Premium	Income from Investments
IC2	Bharti Axa	0.00	0.00	3,505,757,440.00	0.00	205,574,928.00
IC4	Future Generali	0.00	0.00	3,098,925,056.00	0.00	0.00
IC5	HDFC ERGO	418,415,232.00	0.00	0.00	0.00	0.00
IC7	Iffco Tokio	0.00	0.00	0.00	0.00	431,833,024.00
IC8	L&T Insurance	0.00	0.00	568,725,120.00	0.00	13,446,475.00
IC10	New India	0.00	0.00	63,164,653,568.00	0.00	0.00
IC12	Royal Sundaram	0.00	636,268,224.00	0.00	0.00	219,713,728.00
IC13	Tata AIG	17,904,736.00	379,640,832.00	0.00	0.00	592,508,352.00
IC14	United India	0.00	0.00	19,233,019,904.00	0.00	0.00
IC15	Universal Sumpo	89,517,624.00	0.00	0.00	0.00	0.00
IC16	Oriental Insurance	0.00	0.00	32,776,579,072.00	0.00	0.00
IC17	SBI General	0.00	0.00	287,046,880.00	0.00	0.00
IC20	Magma HDI	0.00	0.00	168,008,208.00	0.00	0.00

Source: Authors' Estimates

Appendix.5. Target Values for the Inefficient Insurers

Company Code	Company Name	Net Commission	%	Management Exp	%	Shareholders Capital	%	Net Premium	%	Income from Investments	%
IC2	Bharti Axa	148811637.94	31.72	2431290700.64	31.72	3369419411.79	66.54	8863841774.69	0	253718931.05	427.00
IC4	Future Generali	144031397.84	12.80	2217236134.28	12.80	3092367893.60	56.45	8128259861.70	0	316113995.94	0.00
IC5	HDFC ERGO	717291517.06	62.36	2306641528.89	40.40	4800,050216.34	40.40	12425739068.87	0	562233983.63	0.00
IC7	Iffco Tokio	917322931.56	20.34	3546298009.30	20.34	5334,270904.69	20.34	15339994632.88	0	744870008.78	137.95
IC8	L&T Insurance	25064607.49	75.03	300716847.92	75.03	468304663.06	88.72	1196242062.74	0	33982476.48	65.48
IC10	New India	5869976815.42	42.36	13678294969.29	42.36	76802540510.07	68.37	94506383991.39	0	9306007681.54	0.00
IC12	Royal Sundaram	793348080.15	7.03	2864448,256.85	23.93	4238266014.18	7.03	12406256096.31	0	631758721.39	53.32
IC13	Tata AIG	981378832.01	25.88	3098540,382.04	32.77	4678863869.64	24.53	13877355487.08	0	748911357.47	378.83
IC14	United India	3121614629.97	40.56	11896892067.23	40.56	32474341809.26	62.67	72509438902.99	0	5559799618.18	0.00
IC15	Universal Sumpo	244210325.56	35.74	357736512.57	12.18	3804343709.72	12.18	3413099051.20	0	196776993.28	0.00
IC16	Oriental Insurance	2040973880.08	46.48	9358962794.03	46.48	23061709151.52	77.90	53871076437.31	0	3868362991.75	0.00
IC17	SBI General	112126109.38	79.58	476791781.71	79.58	1046158219.76	83.98	2241258078.58	0	391615007.02	0.00
IC20	Magma HDI	6249508.67	88.09	35208060.99	88.09	79647264.67	96.17	142716575.54	0	29354131.29	0.00
Average			43.69%		42.02%		54.25%		0		81.74%

Source: Authors' Estimate

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