

THE ROADMAP OF PRODUCTIVITY AND PRODUCTIVITY CHANGES OF INDIAN NON-LIFE INSURANCE COMPANIES: A STUDY USING BOOTSTRAPPED MALMQUIST MODEL

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ABSTRACT

Indian Financial sector reforms have got a new swing after the adoption of new Economic Policy by the Indian government. In 1993, the government took the initiative to bring about changes to the insurance sector for the first time with the setting up of the Malhotra Committee. Following the implementations of the suggestions put forward by the Committee, the sector was deregulated in 2000 and invitation was given to the private players national as well as global. During the first decade of the 21st century, the sector grew at a rate of around 20%. Though there have been a few studies covering various issues related to the Indian insurance sector, both life and non-life, the extent of research in this area is not sufficient. The present study is carried out to a closer look into the productivity growth in the Indian non-life insurance sector by applying the bootstrapped DEA methodology by one-input, two output model. This empirical research shows that the overall productivity growth performance is not very encouraging for the sector. In terms of performance, National Insurance is the leading player in the public sector, whereas Cholamandalam Insurance and HDFC Ergo lead among the private players. A little more than 50% of the sample (including one from the public sector), showed a progress during the period. In terms of statistical significance using the bootstrap iterative method, it is seen that in most of the cases, the growth (or de-growth) is not significant. A further analysis into the technical change and technological change has also been looked into by the researchers.

Keywords: *Non-life insurance, Productivity growth, Malmquist, DEA, Bootstrapping*

INTRODUCTION

Corporate Performance assessment practices considering only the financial aspect is very common one and there has been an evolution of different measures to look into that aspect. The present study, strictly does not concentrate on the so-common financial aspect based on annual reports. Instead, it focuses on another aspect of performance that is efficiency. This approach of efficiency measurement is considered to be more relevant over others as it takes into consideration both inputs and outputs at the same time.

In the present study, the sector considered for the study is the non-life segment of the Indian insurance industry. Historical background of the sector shows that the general insurance segment, in line with the life insurance segment, has been undergoing reforms from time to time. The latest major reform took place in the year 2000, when the insurance regulator opened the sector to the private as well as global players. Since then, the growth rate of the industry has taken a new pace, the compounded annual growth rate being close to

20% in the last decade. This is a good sign and it is expected to continue since still there are several opportunities to capitalize upon. Following the Malhotra Committee recommendations, one of the reasons behind opening up of the industry to the private players was the low level of industry penetration and also the low insurance density in India. After such opening up, both the parameters have shown a considerable positive trend as evident from the tables shown below:

Table 1: Non-life Insurance status in India

Year ended 31 st March	Non-Life Insurance	
	Insurance Density* (US \$)	Insurance Penetration** (%)
2001	2.4	0.56
2002	3.0	0.67
2003	3.5	0.62
2004	4.0	0.64
2005	4.4	0.61
2006	5.2	0.60
2007	6.2	0.60
2008	6.2	0.60
2009	6.7	0.60
2010	8.7	0.71
2011	10.0	0.70
2012	10.5	0.78

Source: IRDA Annual Reports

*denotes the premium per capita; **implies insurance premium as a percentage of GDP.

LITERATURE REVIEW

The interest in the area of insurance is slowly gaining importance to the Indian people in general and the academics, professionals and researchers in particular. However, it is worthy to note that this industry, both life and non-life, has been quite intensively explored in other countries, both developed and developing. There are several studies outside the country that have analysed efficiency of insurance companies, mostly non-life, particularly using parametric or non-parametric methods.

Some of the important aspects that have been covered by the earlier researchers include cross-country comparison. Donni and Fecher (1997), Rai (1996) studied efficiency of insurance industry on different organizational forms. Fecher et. al. (1991) examined the impact of mergers and industry reforms on organizational efficiency. Cummins et. al. (2006), Kim and Grace (1995) studied the impact of competition on the efficiency of insurance industry. Bikker and Leuvensteijn (2008) studied the relationship between efficiency and profitability. Greene and Segal (2004) studied the productivity and productivity changes of insurance industry in USA. Kasman and Turgutlu (2008), Fukuyama (1997), Barros, Barroso and Borges (2005) examined the corporate governance issues for insurance companies. Jeng and Lai (2005), Brockett et.al (2005), observed the effect of regulatory changes on insurance industry. Some of the other issues covered under efficiency studies include risk management as is evident in the researches of Brockett et.al (2004), Cummins and Nini (2002).

The Roadmap of Productivity And Productivity Changes of Indian Non-life Insurance Companies: A Study Using Bootstrapped Malmquist Model

Efficiency studies have been popular not only in the developed countries like the US, UK, Germany etc. but also developing economies like India, Japan, Taiwan and other South Asian countries. The work of Tone and Sahoo (2005), Qiu and Chen (2006), Hao and Chou (2005), Hwang and Kao (2008), Saad and Idris (2011) are noteworthy in this aspect. The insurance sector has been widely explored in several European and African countries as well. Some of the economies covered include Netherlands viz. Bikker and Leuvensteinj (2008), Greece - Borges et. al (2008), Spain - Cummins and Rbio-Misas (2006), Germany – Mahlberg (2000), Australia - Worthington (2002) and so on. In the Indian context, some studies have been carried out which have empirically tested the performance of the life and non-life insurance industry and include the studies of Sinha (2007), Sinha and Chatterjee (2007) etc.

If we now look specifically into the aspect covered in those studies, we find that the quantum of research in the area is mentionable. But, the noticeable point is that in very few cases, bootstrapping technique is applied, though ignoring its merit to arrive at correct and concrete statistical conclusions.

In India, Mathur and Paul (2014) looked into the total factor productivity growth of non-life insurance companies in India for the year 2012-13. Another mentionable study by Leverty et. al (2009) studied the effect of WTO on the insurance industry of China. The researcher applied the bootstrapping DEA technique to arrive at the conclusions. Similarly, another study evaluated the efficiency of different distribution channels which found that the direct ones were more effective than the indirect channels. The study by Afza and Asghar (2012) determined the factors affecting efficiency of insurers in Pakistan during the period 2003 to 2007. Similar such studies to assess the overall factor productivity growth along with the probable reasons have been made in respect of other countries as well. [Cummins et. al (1996), Fukuyama (1997), Arjomandi (2011)]

Hence, from the survey of literature, it is seen that there are very few studies on insurance that have applied the bootstrapped DEA methodology. Hence, this study would be among the unique that will help us to arrive at more accurate, reliable and genuine conclusions regarding the productivity and productivity changes of Indian non-life insurance industry.

OBJECTIVES OF THE STUDY

The purposes of this empirical research are:

- to obtain total factor productivity growth of the insurers in the Indian non-life insurance companies.
- to identify the factor(s) contributing to the growth

Hypothesis to be tested:

H₀: The productivity growth rate of an insurer is not significant.

H₁: The productivity growth of an insurer during the period is not zero.

RESEARCH DESIGN

The present study is made on twelve non-life insurers in India, comprising of four from the public sector and the remaining eight from the private sector covering the period 2004-05

to 2012-13. The study is based on secondary data collected from the annual reports of the selected companies obtained from the IRDA website.

In the study, we have applied bootstrapped DEA and Bootstrapped Malmquist index to estimate the productivity of Indian non-life insurance companies and their productivity changes. It is necessary to mention here that there are two common approaches used in efficiency studies:

1. The econometrical approach, in which an assumption about the functional form is made, and
2. The mathematical approach, which does not necessitate the assumption of any functional form regarding inputs and outputs.

Data Envelopment Approach (DEA) is a very popular methodology comes under the latter category. It has some other major advantages which include:

- * Ability to handle several inputs and outputs
- * Comparison of decision-making units directly against a peer or a combination of peers.
- * Inputs and outputs can have different units.
- * Ability to analyse small sample sizes.

The disadvantage, however, is that it does not take into account the random error term. In other words, the extent of inefficiency cannot be broken into genuine and random factors, thereby leading to biased conclusions.

The technique involves the piece-meal addition of individual frontiers that ultimately generates the efficient frontier of the entire data set which envelops all data points (Charnes et al., 1978). This generated frontier (technically referred to as the 'best-practice' frontier) becomes the reference frontier for the computation of efficiency scores which ranges between zero and one. The score of one implies that the decision-making unit is an efficient one, whereas non-zero score, points to the existence of an element of inefficiency, thereby providing a scope for improvement. The difference between the obtained score and the frontier score (score = 1) denotes the scope of improvement of the concerned decision-making unit (Cooper et al., 2007). Hence, it is clear that this technique helps to point out the relative position of the different companies among the sample peers. The combination of input and output of the efficient firms are on the efficient frontier, whereas those of the others below it.

In this study the DEA output-maximisation model has been applied with one input (commission and management expense) and two outputs (investment income and net premium).

In our study, the focus is not on the determination of the efficiency scores but on identifying the productivity growth along with the factors contributing to the growth or de-growth in the general insurance industry of India. For the purpose, Malmquist productivity index is used. The index, pioneered by Caves et al. (1982) and developed further by Färe et al. (1992) relies on distance functions which help to determine the evolution of efficiency over time.

The Malmquist Index captures two basic components:

1. The frontier shift effect (also called technological change) and
2. The catching-up effect (also called efficiency change).

The Roadmap of Productivity And Productivity Changes of Indian Non-life Insurance Companies: A Study Using Bootstrapped Malmquist Model

The former is related to the development of better technology that leads to the shift of the efficient frontier, whereas the latter mentions about the increase or decrease in technical efficiency which helps it to reach closer to the efficient frontier or further away from it.

A score of more than one denotes progress, whereas less than one points to a regress over time (Grosskopf, 1993; Cummins and Weiss, 1999).

Need for application of bootstrapping

The efficiency study applying DEA might suffer from upward biasness, generated through sample bias, thereby leading to incorrect conclusions in some occasions. The reason is that the results may be affected because of the distances to the frontier get underestimated, if the best performers in the population are not included in the sample. Keeping the fact in the backdrop, this empirical study applies the bootstrapping mechanism using Simar and Wilson (2007) approach to take into account the sampling variation by generating pseudo samples through the repetitive data generating process before arriving at the results. These samples taken together calculate the sampling fluctuation, thereby helping in reducing the biasness in the results by approximating the sampling distribution.

The other major advantage of the bootstrapping procedure is that the result provides confidence intervals for the original set of results based on the bootstrap sample. That helps to obtain the statistical significance of the obtained results. Hence, it is easy to understand the genuineness of the result obtained through DEA. Therefore, we may say that bootstrapping is nothing but a further refinement of the result to conclude correctly.

In spite of such an advantage of bootstrapping, a gap exists in the existing literature regarding application of such tool in case of efficiency studies of Indian insurance sector.

ANALYSIS AND FINDINGS

The below-mentioned sub-sections will highlight the findings of the study.

Data Characteristics

In order to understand the nature of the industry, it is immensely important to know about the characteristics of the data for which the descriptive statistics is looked into.

Descriptive statistics of variables during the study period:

Table 2: Commission and Management Expenses (Input Variable):

Statistic	Commission and Management Expense		
	All	Public	Private
Mean	57243.59	125609.75	14876.19
Median	34754.44	102429.49	10682.31
Standard Deviation	58821.92	#N/A	12625.91
Skewness	1.68	4.49	1.44
Minimum	1249.06	245786.42	1249.06
Maximum	321637.00	75850.58	48000.15

Source: Calculated by the authors

Table 3: Gross Investment Income (output variable 1)

Statistic	Gross Investment Income		
	All	Public	Private
Mean	49669.84	128629.57	5413.76
Median	13869.00	117205.54	3366.07
Standard Deviation	62594.08	46072.89	5958.89
Skewness	1.34	1.34	2.25
Minimum	1076.00	68517.00	1076.00
Maximum	278997.00	278997.00	28196.75

Source: Calculated by the authors

Table 4: Net Premium (output variable 2)

Statistic	Net Premium		
	All	Public	Private
Mean	178206.13	369154.36	51293.53
Median	130443.57	299883.31	35771.96
Standard Deviation	214292.44	163312.26	71219.25
Skewness	1.91	2.12	1.28
Minimum	5219.92	209196.43	5219.92
Maximum	1027417.00	1027417	163170.15

Source: Calculated by the authors

Productivity Growth Results

Under the area of productivity growth, the researchers have looked into the aspect of technical efficiency change and technological change using the bootstrap methodology. A noticeable point in the tables is that in certain cases, the “significance” (or insignificance) of the results is observed. It is determined by a very simple process: firstly, the upper and lower bound values are calculated. Then it is checked whether the value of one lies in that range. If it does, the productivity growth is not significantly different from zero. But, if it does not, the value obtained is significant at the chosen significant level. In other words, the percentage of progress (or regress) is significantly different from zero. The table below discusses the results;

Table 5: Efficiency change of insurers

NO	DMU	GM	Technical Efficiency Change							
			04-05 to 05-06	05-06 to 06-07	06-07 to 07-08	07-08 to 08-09	08-09 to 09-10	09-10 to 10-11	10-11 to 11-12	11-12 to 12-13
1	DMU_001	1.029	1.301*	0.956	0.926*	0.999	1.108	0.933	1.059	0.991
2	DMU_002	1.011	1.089	0.714	1.103	1.167*	1.203*	0.844*	1.096	0.983
3	DMU_003	1.007	0.986*	0.744*	0.861	1.074	1.725	0.824	1.121	0.974
4	DMU_004	1.003	0.947	1.092	0.963	1.011	0.996*	1.021	1.014	0.984
5	DMU_005	0.995	1.016	1.005*	0.870	1.157*	0.989	0.912*	1.039	0.994
6	DMU_006	1.047	1.140*	1.213*	1.011*	1.036	0.861*	1.164*	0.998	1.000
7	DMU_007	1.009	1.246*	1.044	0.951	0.964	0.840	1.087	1.028	0.963
8	DMU_008	0.995	0.920	1.091	0.994*	1.002	0.815*	1.161*	1.062	0.958
9	DMU_009	0.985	1.019	0.998*	0.876*	0.992	1.084	0.910*	1.036	0.981
10	DMU_010	1.000	1.070	1.016*	0.851*	1.144*	1.010	0.904*	1.054	0.978
11	DMU_011	1.021	1.179*	1.054*	0.900	1.081*	1.034	0.872*	1.092	0.991
12	DMU_012	1.002	1.083*	0.967	0.997	1.023	1.004	0.918	1.114	0.928

Source: Calculated by the authors; GM = Geometric Mean, DMU = Decision Making Unit

** denotes that the null hypothesis is rejected at 5% level of significance.*

From the above table, it is clear that in terms of technical efficiency improvement, almost all the insurers have shown a positive growth though the rate is very marginal. The maximum growth rate among the private players is observed in the case of Bajaj Allianz with a rate of 2.9% only over the period. Among the public insurers, all but one show a de-growth during

The Roadmap of Productivity And Productivity Changes of Indian Non-life Insurance Companies: A Study Using Bootstrapped Malmquist Model

the period. National Insurance shows the best performance in the industry with a growth rate of close to 5%. Another noticeable point is that in many cases, it is seen that the growth rate is observed to be positive or negative. But, the results of the bootstrapping shows that in maximum of those cases, marked with asterisk (*), the null hypothesis is rejected. In other words, looking into the statistical significance, they are all insignificant growth or at a zero growth rate.

Table 6: Technological change of insurers

NO	DMU	GM	Technological Change							
			04-05 to 05-06	05-06 to 06-07	06-07 to 07-08	07-08 to 08-09	08-09 to 09-10	09-10 to 10-11	10-11 to 11-12	11-12 to 12-13
1	DMU_001	0.943	0.767*	0.954	1.012	0.980	0.938	1.020	0.940	0.956
2	DMU_002	1.113	0.921*	1.581*	1.268*	0.921	0.841*	1.470*	0.889	1.261*
3	DMU_003	1.103	0.997	1.305*	1.193	1.007	0.981	1.299*	1.035	1.061
4	DMU_004	0.965	0.905*	0.856*	1.024	0.985	1.030	1.026	0.947	0.962
5	DMU_005	1.008	0.898*	0.974	1.163*	0.892*	1.003	1.100	0.941	1.136*
6	DMU_006	0.962	1.120	0.825*	0.989	0.941	1.187*	0.861*	0.926*	0.905
7	DMU_007	0.950	0.846*	1.030	1.123	0.887	1.217	0.911	0.927	0.743*
8	DMU_008	0.987	1.038	0.895	1.004	0.968	1.190*	0.904*	0.993	0.937
9	DMU_009	1.040	0.906	1.006	1.151*	1.011	0.922*	1.062*	0.959	1.372*
10	DMU_010	1.030	0.894*	0.955	1.202*	0.904*	1.000	1.112*	0.956	1.280*
11	DMU_011	1.015	0.820*	0.956	1.135*	0.932*	0.973	1.139*	0.950*	1.292*
12	DMU_012	0.967	0.936	0.991	1.003	0.958	1.084	0.984	0.909	0.885

Source: Calculated by the authors

The above table shows the growth or improvement in terms of progress of the technology for the better. In other words, this section says about the extent of upward or downward shift in the efficient frontier during the study period. The growth rate as depicted by the geometric mean shows that none of the public sector insurers showed a positive growth rate. In other words, there has been no progress in terms of technological advancement that can lead them to overall improvement in the productivity. On the other hand, the private sector insurers are better placed. Here, we find 75% of the insurers show progress, with Cholamandalam Insurance and HDFC Ergo having more than 10% growth rate.

Table 7: Malmquist Index Result

NO	DMU	GM	Malmquist Index							
			04-05 to 05-06	05-06 to 06-07	06-07 to 07-08	07-08 to 08-09	08-09 to 09-10	09-10 to 10-11	10-11 to 11-12	11-12 to 12-13
1	DMU_001	0.966	0.993	0.909*	0.935*	0.977*	1.036*	0.948*	0.993	0.946
2	DMU_002	1.117	1.001	1.102	1.367*	1.071*	1.008	1.237*	0.972	1.236*
3	DMU_003	1.100	0.983*	0.962*	1.003	1.074*	1.681*	1.059	1.152*	1.029
4	DMU_004	0.966	0.856*	0.931	0.983	0.995	1.026	1.047	0.958*	0.945
5	DMU_005	1.002	0.913*	0.977	1.010	1.031*	0.992	1.002	0.976	1.127*
6	DMU_006	1.005	1.269*	0.994	0.998	0.973*	1.020	0.999	0.924*	0.903
7	DMU_007	0.947	1.045	1.054	1.049	0.850*	1.008	0.975	0.945*	0.707*
8	DMU_008	0.981	0.952*	0.974	0.998	0.970	0.968	1.047	1.054	0.898
9	DMU_009	1.021	0.919	0.995	1.005	1.001	0.997	0.965	0.991	1.345*
10	DMU_010	1.028	0.955*	0.969	1.021	1.034*	1.010	1.004	1.007	1.251*
11	DMU_011	1.035	0.963*	1.006	1.020*	1.007	1.006	0.991	1.037	1.279*
12	DMU_012	0.968	1.011*	0.958	1.000	0.981	1.088*	0.903	1.011	0.819*

Source: Calculated by the authors

The above table depicts the results of the overall productivity growth of the sample insurers, calculated using Malmquist index. In terms of a positive growth rate, it is observed that only 56% of the sample insurers show a positive growth rate. The highest rate is seen in the case of Cholamandalam Insurance (11.7%) which is closely followed by HDFC Ergo Insurance (10%). If we look at the index values, it is clear that the public sector players have not performed well; National Insurance has grown by a negligible 0.5%, whereas others have shown negative growth rates.

CONCLUSION

A study into the insurance sector reforms regarding the policy measures adopted by the government shows a considerable impact on the sector. The sector has been growing at a rapid pace during the last decade and it is expectedly so, looking at the opportunities in the sector and the untapped potential lying in the industry. IRDA, being the apex regulator has been keenly looking after the sector and formulating regulations from time to time, with the expectation that the insurers will not just do business but will also contribute to the spread of insurance to all boundaries and all sections of the society.

The overall conclusion from the study is that, though business figures show a rapid growth pace in the industry, in reality the productivity growth rate is very low. A comparative analysis of the two sectors shows that the conclusion and the performance varies. A look at the public sector shows that, in terms of Malmquist index, all but one shows a marginal growth. The main reason behind this poor show is mainly because of a lack of technological progress in the sector. On contrary, the private players have put up a better performance in this regard. The main point of improvement is the technical efficiency; the performance in respect of technological improvement has been good. The best performance has been shown by four private insurers viz. Cholamandam Insurance, HDFC Ergo Insurance, Tata AIG and Royal Sundaram, which have shown a growth in both the dimensions that contribute to the overall productivity growth in that order. However, since the gestation period for the industry is over, it would be reasonable to expect that it will be more mature and the insurers will show more improvement in technical efficiency and the progress with respect to technological advancement that will generate benefits for the industry in particular and the people as a whole.

REFERENCES

- Afza, T. and Asghar, M. J. (2012). Financial reforms and efficiency in the insurance companies of Pakistan. *African Journal of Business Management* 6(30), 8957-8963
- Arjomandi, A., Valadkhani, A., and Harvie, C. (2011). Analysing Productivity Changes Using the Bootstrapped Malmquist Approach: The Case of the Iranian Banking Industry. *Australasian Accounting Business and Finance Journal*, 5(4) 35-56.
- Barros, P., Barroso, N., and Borges, M. R. (2005). Evaluating the Efficiency and Productivity of Insurance Companies with a Malmquist Index: A Case Study for Portugal. *Geneva Papers on Risk and Insurance*, 30(2), 244–267.
- Bikker, J. A., and Leuvensteijn, M. V. (2008). Competition and efficiency in the Dutch life insurance industry. *Applied Economics*, 40, 2063-2084.
- Borges, M. R., Nektarios, M. And Barros, C. P. (2008). Analysing the efficiency of the Greek life insurance industry. *European Research Studies Journal*, 6(3) 35-52.
- Brockett, P.L., Cooper, W.W., Golden, L.L., Rousseau, J.J., Wang, Y. (2004). Evaluating solvency versus efficiency performance and different forms of organization and marketing in U.S.

The Roadmap of Productivity And Productivity Changes of Indian Non-life Insurance Companies: A Study Using Bootstrapped Malmquist Model

- property-liability insurance companies. *European Journal of Operational Research*, 154,492-514.
- Brockett, P. L., Cooper, W. W., Golden, L. L., Rousseau, J. J., and Wang, Y. (2005). Financial Intermediary versus Production Approach to Efficiency of Marketing Distribution Systems and Organizational Structure of Insurance Companies. *Journal of Risk and Insurance*, 72 (3),393-412.
 - Caves, D.W., L.R. Christensen and Diewert, W. E. (1982b). The Economic Theory of Index Numbers and the Measurement of Input, Output, and Productivity. *Econometrica*, 50,1393-1414.
 - Charnes, A., Cooper, W. W. and Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, 2,29-444.
 - Cooper, W. W., Seiford, L. M., and Tone, K. (2007). Data Envelopment Analysis: A Comprehensive Text with Models, Applications, *References and DEA-Solver Software* Boston, Springer, MA.
 - Cummins, J.D. and Nini, G. (2002). Optimal capital utilization by financial firms: Evidence from the property-liability insurance industry. *Journal of Financial Services Research*, 21,15-53.
 - Cummins, J. D., Weiss, M. A., and Zi, H. (1999). Organizational Form and Efficiency: The Coexistence of Stock and Mutual Property-Liability Insurers. *Management Science*, 45(9),1254-1269.
 - Cummins, J. D., and Rubio-Misas, M. (2006). Deregulation, Consolidation, and Efficiency: Evidence from the Spanish Insurance Industry. *Journal of Money, Credit, and Banking*, 38(2), 323-355.
 - Donni, O. and Fecher, F. (1997). Efficiency and Productivity of the Insurance Industry in the OECD Countries. *Geneva Papers on Risk and Insurance*, 22(84),523-535.
 - Fare, R., S., Lindgren G. P. and Ross, P. (1992). Productivity change in Swedish pharmacies 1980-1989: A non-parametric Malmquist approach. *Journal of Productivity Analysis*, 3(2),85-102.
 - Fecher, F., Perelman, S., and Pestieau, P. (1991). Scale Economics and Performance in the French Insurance Industry. *Geneva Papers on Risk and Insurance*, 16(60),315-326.
 - Fukuyama, H. (1997). Investigating productive efficiency and productivity change of Japanese life insurance companies. *Pacific-Basin Finance Journal*, 5(4),481-509.
 - Greene, W. H. and Segal, D. (2004). Profitability and Efficiency in the U.S. Life Insurance Industry. *Journal of Productivity Analysis*, 21(3),229-247.
 - Grosskopf, S. (1993). Efficiency and Productivity in *Fried HO and SS Schmidt (eds.) the Measurement of Productive Efficiency: Techniques and Application* Oxford U.K. 160-194.
 - Hao, J.C.J. and Chou, L. (2005). The Estimation of Efficiency for Life Insurance Industry: The Case in Taiwan. *Journal of Asian Economics* 16, 847-860
 - Hwang, S. N. and Kao, C. (2008). Efficiency Decomposition in Two-Stage Data Envelopment Analysis: An Application to Non-Life Insurance Companies in Taiwan. *European Journal of Operational Research*, 185(1),418-429.
 - Jeng, V. and Lai, G.C., (2005). Ownership structure, agency costs, specialization, and efficiency: analysis of Keiretsu and independent insurers in the Japanese non life insurance industry. *Journal of Risk and Insurance*, 72,105-158.
 - Kasman, A., and Turgutlu, E. (2009). Total factor productivity in the Turkish Insurance industry. *International Journal of the Economics of Business*, 16(2),39-247.
 - Kim, H. and Grace, M. F. (1995). Potential Ex Post Efficiency Gains of Insurance Company Mergers. Working Paper, Center for RMI Research 95-4, College of Business Administration, Georgia State University, Atlanta.
 - Leverty, J. T., Lin, Y. and Zhou, H. (2008). WTO and the Chinese Insurance industry. *Geneva Papers on risk and finance*, 34(3),440-465

- Lin, H. D., Lee, Y. H. and Shih, M. L. (2010). A Study on Technical Efficiency and Productivity Changes of Taiwan’s Life Insurance Industry. Retrieved from Journal of Global Business Management, online website <http://www.jgbm.org>
- Mahlberg, B. and Url, T. (2010). Single market effects on productivity in the German insurance industry, *Journal of Banking and Finance*, 34,1540-1548
- Mathur, A., and Paul, U. K. (2014). Performance Appraisal of Indian Non-Life Insurance Companies: A DEA Approach. *Universal Journal of Management*, 2(5),173-185.
- Qiu, S., and Chen, B. (2006). Efficiencies of Life Insurers in China—An Application of Data Envelopment Analysis. *Working Paper*
- Rai, A. (1996). Cost Efficiency of International Insurance Firms. *Journal of Financial Services Research*, 10(3), 213–234.
- Saad, N. and Idris, N. E. (2011). Efficiency of Life Insurance Companies in Malaysia and Brunei: A Comparative Analysis. *International Journal of Humanities and Social Science*, 1(3),11-122.
- Simar, L. and Wilson P. (2007). Estimation and Inference in Two-Stage, Semi-Parametric Models of Production Processes. *Journal of Econometrics*, 136(1),31–64.
- Sinha, R.P (2007). Productivity and Efficiency of Indian General Insurance Industry. *The ICFAI Journal of Risk & Insurance*, 4(2),33-43.
- Sinha, R.P and Chatterjee, B. (2007). Are Indian Life Insurance Companies Cost Efficient? accessed at http://www.igidr.ac.in/money/mfc-11/Sinha_Rampratap.pdf on 01st November, 2011.
- Tone, K., and Sahoo, B. K., (2005). Evaluating Cost Efficiency and Returns to Scale in the Life Insurance Corporation of India using Data Envelopmental Analysis, *Socio-Economic Planning Sciences*, 39, 261-285
- Verma, R. (2012). A Study of perceptive and productivity of health insurance business in India with reference to key determinants. *International Journal of Research in IT & Management*, 2(2), 868-881.
- Worthington, A. (1999). Malmquist Indices of Productivity Change in Australian Financial Services. *Journal of International Financial Markets, Institutions and Money*, 9(3),3-320.
- Annual reports retrieved in July, 2014 from www.irda.gov.in.

Annexure 1
List of insurers in the Sample

DMU Number	Name of the bank
DMU_001	Bajaj Allianz General Insurance
DMU_002	Cholamandalam Insurance
DMU_003	HDFC Ergo Insurance
DMU_004	ICICI Lombard General Insurance
DMU_005	IFFCO Tokyo Insurance
DMU_006	National Insurance
DMU_007	New India Assurance
DMU_008	Oriental Insurance
DMU_009	Reliance General Insurance
DMU_010	Royal Sundaram Insurance
DMU_011	Tata AIG Insurance
DMU_012	United Insurance