CHAPTER-V

EFFICIENCY AND PRODUCTIVITY

This chapter is concerned with the efficiency and productivity of life insurers in the wake deregulation of Indian insurance. The life insurance companies have made tremendous progress in terms of business growth following deregulation and there is little research on the efficiency analysis of life insurance companies in Indian context. Almost all the research studies attempted to discuss the impact of liberalization in terms of business performances based on premium income, policies sold etc. Efforts are also being made here to compare the relative performances of life insurers. The results will give a key to understand whether or not the aim of liberalization process has achieved in Indian life insurance market.

5.1: EFFICIENCY:

5.1.1-Concept of Efficiency:

Efficiency refers to how well firms are performing relative to the existing technology in the industry. The concept of economic efficiency flows directly from the microeconomic theory of firm. In microeconomic theory of firm, production (or economic) efficiency is decomposed into technical and Allocative efficiency. A producer is said to be technically efficient if production occurs on the boundaries of producer's production possibilities set and technically inefficient if production occurs on the interior of the production possibilities set. That is, technical efficiency is the extent to which maximum possible output is achieved from a given combination of inputs. On the other hand, a producer is said to be

allocatively efficient if the production occurs in a region of production possibilities set that satisfy the producer's behavioral objective.

5.1.2-Estimation Technique:

Firm performances can be measured using various methods; conventional financial ratios such as return on assets (ROA), return on equity (ROE), expense to premium ratios etc. However frontier methodologies have been regarded superior to the traditional methods in the economic theory. The frontier methodologies measure firm performance relative to ''best practice'' frontiers consisting of the other firms in the industry. Frontiers have been estimated to measure firm success in employing technology (technical efficiency), attaining optimal size (scale efficiency), minimizing costs (cost efficiency), maximizing revenues (revenue efficiency), and maximizing profits (profit efficiency).

Two frontier efficiency approaches has so far been used namely Parametric and non parametric approach or technique. Data envelopment analysis (DEA) and Free Disposable Hull analysis (FDH) are among the non parametric approaches used for efficiency estimation. Stochastic frontier approach (SFA), thick frontier approach (TFA), and distribution free approach (DFA) are among the parametric approach used. The economic or parametric approach requires the specification of a production, cost, revenue or profit function as well as assumption about the error terms. The mathematical programming or non parametric approach does not require specification of error terms. Both the parametric and non parametric approaches have advocates and neither has emerged as dominant till date. Box 5.1 summarizes some important techniques used so far in efficiency of insurance industry.

For this study, DEA is adopted for the following reasons: (1) Unlike the econometric approach, DEA deals with multiple outputs as well as multiple inputs, but does not require exogenous specification of the parametric form of the production function. Because, it is a non-parametric method and thereby it is not necessary to identify a functional form or make distributional assumptions. This makes DEA particularly useful in dealing with insurance industry which is a service industry where there is limited knowledge of underlying production technology and typically confronted with multiproduct firms (2) Indian life insurance industry is relatively small and DEA can ideally be able to handle relatively small sample sizes, (3) It allows for convenient decomposition of total technical efficiency (TE) into pure technical efficiency (PTE) and scale efficiency (SE); and (4) As this approach focuses primarily on the technological aspects of production functions, it can be used to estimate productive efficiency without requiring estimates of input and output prices. Based on DEA, the Malmquist technique, which is the standard approach for measuring the evolution of productivity and efficiency over time, is used in the next section of this chapter.

Box 5.1: Summary of studies of insurance industry's efficiency

year	Author	Firm/industry	Country	Methodology
1993	Fecher, Kessler, Perelman and Pestieau	Life and Non-life	France	DEA &SFA
1993	Cummins and Weiss	Property liability	US	SFA
1993	Gardner and Grace	Life	US	DFA
1993	Yuengert	Life	US	SFA &TFA
1995	Cummins,Weiss and Zi	Property liability	US	DEA
1995	Cummins and Zi	Life	USA	SFA,DFA,DEA &FDH
1996	J D Cummins , J Turchetti and M A.Weiss	Life & Non-life	Italy	DEA
1996	Berger,Cummins and Weiss	Property liability	US	DFA
1999	Rees et al.	Life	Germany, UK	DEA
2000	Jaehyum Kim	Non life		DEA
2000	Mahlberg and Url	Non life	Germany	DEA
2000	Ryan/Schellhorn	LIfe	US	DFA
2001	H. Fukuyama and Weber	Non life	Japan	DEA
2002	Thitivadee Boonyasai, Martin F.Grace and H.D Skipper	Life Insurance	Korea, Philippines, Taiwan and Thailand	DEA
2003	Bernhard Mahlberg, Thomas Url	Insurance industry	Austria	DEA
2004	Ennsfellner et.al	Life/Health, Non life	Austria	SFA
2004	W.H. Greene and Dan Segal	Life insurance	US	SFA
2004	Turchetti and Daraio	Motor	Italy	DEA
2005	Tone and Sahoo	Life	India	DEA
2006	Stephanie Hussels and DR Ward	Life Insurance	Germany &UK	DEA,DFA
2006	Badunenko et al.	Life, Non- life	Ukraine	DEA
2006	J David Cumin and Maria Rubio-Misas	Life ,Non -life	Spain	DEA
2008	Yuan and Phillips	Life ,Property-liability	US	SFA
2008	Trigo Gamarra	Life	Germany	SFA

(Note: DEA: Data Envelopment analysis, DFA: Distribution free approach, SFA: Stochastic frontier approach, TFA: Thick frontier approach, FDH: Free disposable hull analysis)

Estimation of efficiency using DEA:

Farrell (1957) first introduced the concept of the efficiency frontier and application of DEA. It was further developed by Charnes, Cooper, and Rhodes (1978). The DEA analysis uses a linear programming

technique to construct an envelope for the observed input output combinations of all market participants under the constraint that all best practice firms support the envelope, while all inefficient firms are kept, off the frontier. The result of the DEA analysis can be used to assess the technical efficiency of individual firms with respect to the best practice or benchmark firms. It also allows decomposing the technical efficiency into pure technical and scale efficiency.

Technical efficiency can be decomposed into pure technical efficiency (PTE) and scale efficiency (SE), where TE = PTE x SE, by solving additional linear programming problems. Pure technical efficiency is measured relative to a variable returns to scale (VRS) frontier, which may have segments where best practice firms operate with increasing returns to scale (IRS), constant returns to scale (CRS), and/or decreasing returns to scale (DRS). Pure technical efficiency is the reciprocal of the distance of firm i from the VRS frontier. Thus, the firm could achieve pure technical efficiency by moving to the VRS frontier. If the firm is operating in an IRS or DRS region of the frontier, it could further improve its efficiency by attaining CRS. Both pure technical and scale efficiency are bounded by 0 and 1. Firms with pure technical efficiency equal to 1 are operating on the VRS frontier, and a scale efficiency score equal to 1 indicates that a firm is operating with CRS. The methodology also reveals whether a non-CRS firm is operating with IRS or DRS

To estimate the technical efficiency for individual companies, Data Envelopment Analysis (DEA) developed by Charnes et al. (1978) is used in the study. Efficiency is measured here under two different assumptions, viz.

1) Variable Returns to Scale (VRS) model, which permits increasing and decreasing returns to scale. Here, the sum of weights of linear program is restricted to 1.This gives the measure of pure Technical Efficiency.

2) The Constant Return to Scale (CRS) model which assume a non negativity constraint instead of the VRS constraint on weights. This gives the measure of Technical efficiency.

For one output and one input case, the envelope which fulfills the VRS condition is shown in Fig.5.1 as the dashed line. The solid line in the figure indicates the envelope of CRS. The combinations of inputs and outputs of efficient firms support the efficiency frontier whereas that of inefficient one lies to the right or below the frontiers in the Figure. Technical efficiency is defined as the ratio of the input usage of a fully efficient firm producing the same output vector to the input usage of a specified firm. The point D given is a case of inefficient firm which can either increase production using the same amount of input i.e. output maximization or decrease input holding the output constant i.e. input minimization. B indicates the point where a firm is operating optimally with available technology. At this point, the firm therefore is efficient under CRS as well as VRS. Under CRS, the ratio of distance $D_{CRS}D/0D$ serves the input oriented measure of technical efficiency and its value varies over the range (0, 1). The firm at D is inefficient and its ratio is smaller than 1 whereas for B, B_{CRS} and B coincides so ratio is 1.The fraction (1- $D_{CRS}D/0D$), on the other hand shows the potential input savings that a shift to technically efficient production would bring about. In case of VRS, the ratio based on VRS as reference technology provide an efficiency technology under VRS assumption. So under VRS assumption firm A, B and C are efficient.

The input minimization model of DEA is used which is given as

Min θ_0

Subject to $\sum y_{rj} \lambda_j \geq y_{r0,}$

$\theta_0 x_{i0} - \sum x_{ij} \lambda_j \geq 0$ $\theta_{0\ free,} \lambda_j \geq 0$

$\sum \lambda_j = 1$ for VRS

$\sum \lambda_j \geq 0$ for CRS

Where

θ_0 is the efficiency score of the firm.

j indicates the number of firms, j=1.....J

y_{rj} is the r^{th} output of the j -th firm and x_{ij} is the i -th input of the j -th firm. y and x are output and input of the firms where y=1.....r and x=1,.....i. The above procedure of minimizing efficiency score of θ_0 of a single firm is repeated for each firm and thus the input oriented efficiency of each firm is obtained. Technical efficiency is decomposed into pure technical efficiency and scale efficiency. The scale efficiency (SE) which is the ratio of CRS efficiency to VRS efficiency is also calculated.

OUTPUT:

The lack of establishing a positive theory of the financial firm may be attributed to the incomplete application of the essential elements of the theory of the firm to financial institutions. Most of the areas ignored by writers are, appropriate classification of inputs and outputs of the financial firms by failing to consider the criteria on which financial firms make economic decision, analyzing of the technical aspects of production and cost for the financial firm.

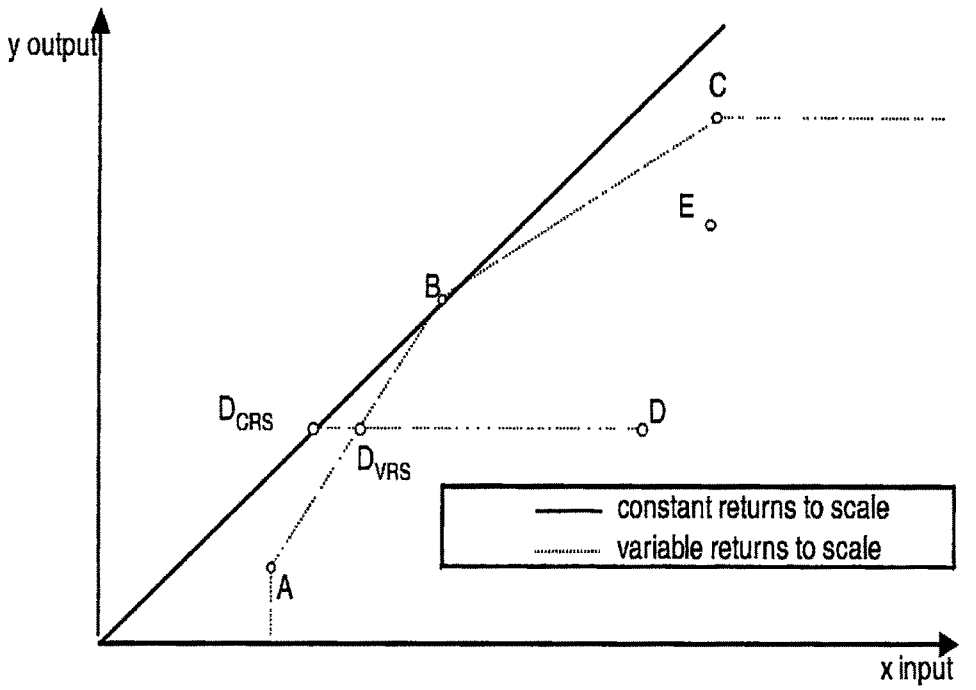

Figure 5.1: Efficiency frontiers under CRS and VRS

One of the major confusions in the theory of the financial firm arises over the lack of agreement concerning appropriate measures of output and inputs for the financial firm. This confusion is a direct result of the failure to carefully analyze both the technical and economic aspects of production at financial institutions. Moreover, the life insurance industry provides a good example of some of the major problems involved in measuring the production of services. In life insurance industry, defining the output is a crucial initial problem followed by the question of how to evaluate relative importance of each output so as to construct a single index of industry production. Three principal alternative methods have been used so far to measure output in financial service sector. Viz. asset

approach, user cost approach and value added approach (Berger and Humphery, 1992).

The asset approach treats financial service firms as pure financial intermediaries i.e. borrowing funds from one set of decision makers, transforming the resulting liabilities into assets, and receiving and paying out the interest and dividend to cover the time value of funds used in this capacity. Intermediation is one of the important functions of life insurers. However intermediation alone cannot be considered as output for life insurance as it also provides many other services in addition to financial intermediation. Therefore, asset approach is not considered for measuring life insurance output.

The user cost approach determines whether a financial product is an output or input on the basis of its net contribution to the revenue of financial institution. If the financial return on an asset exceeds the opportunity cost of fund or if the financial costs of a liability are less than the opportunity cost then the product is said to be a financial output. Otherwise it is classified as financial input. Theoretically, this approach is quite sound but precise data on product revenues and opportunity costs are required. Since relevant data as such are not available for Indian Life Insurance Industry, the use of user cost approach for output measurement is also ruled out for the study.

The value added approach considers all assets and liability categories to have some output characteristics rather than distinguishing inputs from outputs in a mutually exclusive way. Consistent with most of the recent literatures (Cumins & Maria R, 2006; Boonyasai T& et, 2002; Yang Mingliang (2006),) on financial institution, a modified version of

value added approach is used for the measurement of output. The categories having significant value added, as judged using operating cost allocations are employed as important output. Others are treated as unimportant output, intermediate product or input depending on the characteristics of the specific activity under consideration. Based on the value added approach, the following discussions are made—Life insurers in general provide the following three principle services viz. risk pooling and risk bearing , real financial services relating to insured losses and intermediation.

a) Risk pooling and risk-bearing: - Insurance provides a mechanism through which consumers and businesses exposed to losses can engage in risk reduction through pooling. Insurers collect premiums in advance from their customers and redistribute most of the funds to those policyholders who sustain losses. The actuarial, underwriting and related expenses incurred in risk pooling are important components of value added in the industry. The insurers also add value by holding equity capital to bear the residual risk of the pool.

b) Real financial services relating to insured losses: - Life insurers provide a variety of real services for the policy holders. This includes personal financial planning, administration of group life, annuity and health insurance plans. By contracting with insurers to provide these services, policyholders can take advantage of insurer's specialized expertise to reduce cost associated with insurable risks.

c) Intermediation: - For life insurers intermediation is the principal function, accomplished through the sale of asset accumulation products such as annuities. The insurers issue debt contracts (policies and annuities) and invest the funds until benefits are paid. In life insurance, interest credits

are made directly to the policyholder's accounts to reflect the investment income and to compensate for the opportunity costs of the funds held by the insurers. The borrowed funds are invested mainly in marketable securities such as privately placed securities and structured bonds. The net interest margin between the rate of return earned on assets and the rate credited to policyholders is the value added of the intermediation function.

Defining and measuring output in insurance industry has been a challenging task. In value added approach, usually, several types of outputs are defined, representing the single lines of business under review. Thus different output proxies are used for life and property-liability insurers, reflecting differences in the types of insurance and data availability (Berger. A. N., Cummins, J. D., Weiss, M. A., Zi H., 2000). Premium income, weighted sum of activities, incurred benefits, addition-to-reserve, present value of real losses incurred are the most commonly used output so far.

Net written premiums or net earned premiums have been used as proxies for output in various cost studies. (Fecher et.al 1993).Premiums can be viewed as including the flow of services to policyholders for a certain period .However premiums are not the quantity of output but the revenue (price times quantity). Systematic differences in price across large and small firms may leads to misleading inferences about average costs if premiums are taken as output. Doherty (1981) criticized the used of premiums as output because it results into simultaneous equation bias. However Allen (1974) and Blair et al (1975) used premium income as appropriate output considering that the product is more or less

homogeneous and competitive pressure compel all insurers to charge same price. In literature, there is an intense debate as to whether premiums are an appropriate proxy because they represent price times quantity of output and not output (Yuengert, 1993).

In the weighted sum of activities approach, instead of unobservable implicit prices uses weighted sum of the quantity of services produced in each category. Hirshhorn and R. Geehan (1977) used life insurance industry's output by aggregating 29 activities of life insurance companies. Each activity was weighted by an index value and summed up for the output proxy. The activities included not only the most product line of life insurers but also different assets amounts. This approach is useful in considering the differences in aggregate output but provide little assistance in measuring the variations in activities among different firms. The method is biased for inefficient firm over efficient firm as it assumes that the value of expenses equal the value of life insurance output (i.e., ordinary life, group annuities and group life) that is, some insurers may incur more expenses than other not because they produce more output but they are less efficient. Moreover, this approach fails to recognize the risk bearing and risk pooling function of life insurers.

Addition -to-reserves as a proxy of output was suggested by Yuengert (1993). These measures equal reserves set up for new business and new deposit fund and reserves set up as policies ages. The most important shortcoming of this output measurement approach as intermediation function is that it does not consider the benefits delivered to customers during the period, which is the primary service of insurers.

Therefore, outputs measured by addition to reserve approach may underestimate the total output of an insurance firm.

Ennsfellner Karl C. and et.al (2004) used incurred benefits net of reinsurance in a given year as a proxy for risk bearing function of life and health insurance. While, total invested assets and changes in reserves net of reinsurance proxy the intermediation function for life and health insurance. Incurred losses net of reinsurance and incurred benefits net of reinsurance represent the insurer's payments net of reinsurance in the current year. Incurred benefits represent the risk bearing services.

Several cost studies defined incurred benefit plus addition to reserve as output of life insurance industry (Cummins et al. 1996, Cummins et al. 1998) .However use of incurred benefits still have the problems although it captures the flow of services provided to customers in a certain period. Addition- to- reserves also is not immune to differences in prices, reserving methods and interest assumptions across firms.

Berger, Cummins and Weiss (1997) argued that the real losses incurred are a satisfactory proxy for the amount of risk pooling and real insurance services provided. The losses incurred are defined as the losses that are expected to be paid as a result of providing insurance coverage during a particular period of time. Because the objective of risk pooling is to collect funds from the policy holder pool and redistribute them to those who incur losses, proxying output volume by the amount of losses incurred seems quite appropriate. Losses are also a good proxy for the amount of real services provided since the amount of claims settlement and risk management services are also highly correlated with loss

aggregates. Losses incurred are a satisfactory measure of output for coverage provided during a given year. However, insurers also perform services in connection with claims occurring in prior years or claims expected to occur in the coming years. As a proxy for these services, the real value of policy reserve is used.

Boonyasai T.et al (1999) used premium income and net investment income as output. Wherein premium income represented risk-bearing and risk-pooling services, and for the intermediation function of borrowing from the policyholders and investing the funds to marketable securities, net investment income is used as a proxy.

This study used both premium income and benefit paid to customers as output. Although the use of premium income as output is subjected to simultaneous bias, there are constraints imposed by data in the developing countries like India. Also there is still debate among those using the value-added approach as to whether claims/benefits or premiums/sum insured are the most appropriate proxy for value added. More studies use claims/benefits to proxy output than premiums/sum insured, however, there is no recognizable trend over time as to whether either of the two main proxies is gaining more of a following among researchers (Eling Martin und Michael Luhnen, 2009). So premium income may be use as an appropriate proxy of output for risk pooling / risk bearing function. Benefits paid are correlated with the function of real financial services of the insurer.

INPUT

Inputs are somewhat easier to identify and measure as compare to output in the insurance industry as units of measurement tends to be

tangible or at least directly observable. Insurers input can be classified into four principal groups: acquisition (marketing and distribution) input mainly agent labour, managerial and administrative input, fixed capital (office buildings and computer) and financial equity capital. Labor, fixed capital and financial equity capital are the factor of production for insurers. Equity capital is primary input into the risk pooling and risk bearing function, because the insurer must maintain the equity capital to ensure their promise to pay losses that are larger than the expected. Cost studies mainly used three inputs viz. labor, capital and materials. Labor input may consist of employees, agent and brokers. Agent and brokers are mainly responsible for marketing of products while employee's labor include managerial and clerical workers. The labor input volume of all the employees and agents for each company may be obtained by summing all the wages, salaries and benefits provided to employees and all the commission and benefits given to agents.

There is no consensus on the measurement of capital input quantity in previous cost studies. Physical capital represents the expenditure on equipments and occupancy costs. Grace and Timme (1992), Yuengert (1993), Gardner and Grace (1993), and Kim and Grace (1995) used physical approach to measure the capital input. Wherein, the amount of physical capital used by the insurance companies in producing their outputs measured by the value of physical capital assets is used as a proxy of this input.

However, Cummins and Weiss (1993), Cummins et al. (1996) and Cummins et al (1998) used the financial capital instead of physical capital to measure the capital quantity. They argue that the capital structure of insurance industries is quite different from manufacturing industries in

that an insurance company's capital consists mainly of financial capital. Financial capital is crucial input in insurance as the insurer must attain equity capital to assure policyholders that they will receive payments even if experience is below expectations. Therefore financial capital more closely represents real capital in producing output. The financial capital obtained by summing capital and surplus is used as a proxy for financial capital input. (T. Boonyasai et al).

All other input associations, other than labor input, physical capital and financial capital inputs are categorized as material or business and services input. In life insurance, materials or business and services input consists of communication services, rent, equipment rentals, stationary and professional services rendered by external lawyers, physician, actuaries and accountants. Including these inputs allows the estimation to account for variation across insurers to expenditure on computers, communication services and other technology- related items. Cummins and Weiss (1998) computed the volume of business and services by dividing the expenditure on these inputs by consumer price index.

Ennsfellner et al (2004) used Net operating expenses as a proxy for distribution of insurance products, the inputs of their labor force, business services and materials used in the production of insurance products. Equity capital and technical provisions proxy the inputs for the risk bearing and risk pooling function of the insurers.

Following the above studies operating expenses and commission expenses are used as input proxy. The use of operating expenses and commission expense as input is justifiable because, operating costs of life insurance will take into account the labor-related expenses, capital

expenses, and materials consisting of all other expenses. In addition to operating expenses, commission expense is another input in line of labour input as agent and brokers are mainly responsible for marketing of products.

Box 5.2: Overview of input and output used by authors in DEA based efficiency analysis of life insurance firms

Author	Country	Input	Output
Fecher et al.(1993)	France	Labour cost, Other outlays	Gross premiums
Cummins et al. (1996)	Italy	Labor (acquisition, admin.), fixed capital expense, equity capital	Sum of life insurance benefit, changes in reserve, invested assets.
Fukuyama(1997)	Japan	Labour(office, sales),capital	Insurance reserves, Loans
Donni& Fecher(1997)	15 OECD countries	Labour	Net premiums
Cummins and Zi (1998)	US	Labour, financial capital, materials	Benefit payments ,addition to reserves
Cummins (1999)	U.S	Labor (admin., agents), business services, financial capital	Incurred benefits, addition to reserve
Cummins et al. (1999a)	U. S	Home-office labor, agent labor business services (including physical capital), financial capital	Incurred benefit, addition to reserves
Kessner and Polborn(1999)	Germany	New business cost, administration cost	Sum insured of new and in-force business
Carr et al. (1999)	U.S	Labor (admin., agents), business services, financial capital	Incurred benefit, addition to reserves
Rees et al. (1999)	Germany and U.K	Distribution cost, administration cost	Total premium income and change in total premium income (U.K.), aggregate sum insured and change in aggregate sum insured (Germany)
Mahlberg (1999)	Austria and Germany	Administration and distribution cost(1 input)	Claims, Change in reserves, refund of premium
Mahlberg (2000)	Germany	Administration and distribution cost(1 input)	Claims, Change in reserves, refund of premium
Mahlberg and Url(2000)	Germany	Administration and distribution cost(1 input)	Claims, net change in provisions, allocated investment returns, bonuses, and returned premiums
Mansor and Radam(2000)	Malaysia	Claims, commission, salaries, expenses, other cost	New policy issued, premiums, policy in force
Kessner (2001a)	Germany and U. K	New business cost, administration cost, cost for	Gross and net written premiums, interest on capital

		capital management, reinsurance contributions	
Kessner (2001b)	Germany	-Do-	Sum insured (new and existing business), net returns on capital investments
Boonyasai et.al.(2002)	Korea, Philippines, Taiwan, Thailand	Labor, Capital, Materials	Premium income, net investment income
Chaffai and Ouertani(2002)	Tunisia	Labor, physical capital, financial capital	Total premium earned
Mahlberg and Url(2003)	Austria	Administration and distribution cost, cost of capital investment	Claims, net change in provisions, allocated investment returns, bonuses and returned premiums
Leverty et al.(2004)	China	Business expenses, financial equity capital, debt capital	Net premiums written ,real invested assets
Cummins/Rubio-Misas/Zi (2004)	Spain	Labor, business services, debt capital, equity capital	Life insurance losses incurred
Tone &sahoo(2005)	India	Labour, business services, debt capital ,equity capital	Present value of real losses incurred, ratio of liquid assets to liabilities
Barros et al. (2005)	Portugal	Wages, capital, total investment income, premiums issued	Claim Paid, profits
Hussels and Ward(2006)	Germany, U.K	Labor, Capital	Net written premium. Addition to reserves
Qiu and Chen (2006)	China	Labor, equity capital, other	Benefit payments, addition to reserve, yield on investment
Badunenko et al.(2006)	Ukraine	Fixed assets, current assets, liabilities, equity	Premiums
Cummins and Rubio- Misas (2006)	Spain	Labor, business services, debt capital, equity capital	life losses incurred, reinsurance reserves, invested assets
Barros and Obijiaku(2007)	Nigeria	Capital, operative costs, number of employees, total investments	Profits, net premium, settled claims, outstanding claims, investment
Cummins et al. (2007)	U. S	Labor (office, agent), materials and business service, financial equity capital	Real value of incurred benefits, addition to reserves
Erhemjamts and Leverty (2007)	U.S	Labor, business services, equity capital ,policyholder-supplied debt capital	Incurred benefit, addition to reserves
Diboky and Ubl (2007)	Germany	Labor, business services, financial debt capital, equity capital	Gross premium, net income
Jeng et.al (2007)	U.S	VA: Labor, business services, capital (debt + equity) FI: Surplus previous year/assets change in surplus/assets, under- writing + investment expenses/assets, policyholder debt capital/assets	VA: Number of policies, total invested assets FI: Return on Assets (ROA), three principal components of financial conditions
Klumpes (2007)	7 Europeans countries	Labor, business services, debt capital, equity capital	Premiums ,investment income
Yao et al. (2007)	China	Labor, capital, payment and benifit	Premiums, investment income
Davutyan and	7 Europeans	Labor, business services,	Present value of losses

Klumpes (2008)	countries	equity capital	incurred, premium, invested assets
Eling and Luhnen(2008)	36 countries	Labor and business service, financial debt capital, equity capital	Benefit +addition to reserves, Investment
Trigo Gamarra and Growitsch (2008)	Germany	Acquisition and administration expenses, equity capital	Incurred benefits, additions to reserves, bonuses and rebates

(Source: Eling Martin und Michael Luhnen (2009)

DATA:

23 life insurance companies were registered with IRDA including LIC of India as on31st August 2010. However, only 12 to 15 insurers were taken for the study as the insurers who have entered into the industry after 2005 are not considered for the study. The number of insurance company varied year wise as their year of registration and consequent operation vary. For the year 2001-02, only 12 life insurer's data are available as Aviva life insurance Co. Ltd. started its operation in 2002-03 only. Likewise from 2002-03 to 2004-05, 13 life insurers are considered and 14 insurers are taken in 2004-05 for study. From 2005-06 onwards 15 companies are taken together. The data used are from the Insurance Regulatory and Development of India's (IRDA) Annual Report if otherwise not mentioned. For the study, two inputs viz. commission expense and operating expense while two output viz. premium and benefit paid are taken for each life insurers. The values of input variables viz. commission expense and operating expense in lakh are shown in appendix table A.4 while that of output variables namely premium and benefit paid are put in appendix table A.5. The descriptive statistics for these inputs and outputs are shown in table 5.1 and 5.2 respectively. A firm whose input or output is 0 is excluded from the calculation of descriptive statistics irrespective of the year taken. Therefore, in 2001-02, the statistics are calculated for 12 life insurers and

in that for the benefit paid; only 6 insurance companies are undertaken as the values of remaining companies are 0. In 2002-03 and 2003-04, the statistics are based on all the 13 companies. In 2004-05 and 2005-06, of the respective 14 and 15 companies, the statistics of benefit paid is calculated with one company less for each year. From 2006-07 onwards the statistics are based on all the 15 companies taken.

The maximum and average values of input variables were consistently increasing over the years while that of minimum values fluctuated from year to year. The SD of the input variables were also increasing over the years but decreased in 2004-05 in case of commission expense, while it was decreased in 2005-06 in case of operating expense. The maximum, average and SD of output variable, premium, has been increasing over the years .The minimum values were fluctuating but, increasing since 2005-06 for both the outputs. This may be because the latest entrant produced the minimal output. The maximum, average and SD of benefit paid were increasing over the years except in 2008-09.

5.1.3-Result Analysis:

Table 5.3 shows the gross efficiency (technical efficiency) of life insurers calculated at constant return to scale. LIC of India has got gross efficiency score of 1 in CRS models in all the 9 years from 2001-02 to 2009-10 indicating efficient throughout the years. Among private insurers, SBI life was the only insurer which was at par with LIC of India in all years taken. Aviva and ICICI have shown a consistent increase in efficiency scores over the years.

Table 5.1: Descriptive statistics of inputs (Rs in lakh)

Year	Number of firms	Commission expenses				Operating expenses			
		max	min	Average	SD	max	min	Average	SD
2001-02	12	451791	7	38057.58	130293.1	426040	653	38951.42	121928.6
2002-03	13	499861	167	39636.38	138284.9	462109	2330	41932.08	126309.1
2003-04	13	573384	547	47367.23	193971.4	504233	4465	49426.77	136794.9
2004-05	14	624517	66	50704.43	165241.7	598718	177	58682.86	155795.2
2005-06	15	709492	379	57569.87	180606.6	604156	1121	64073.6	150537.5
2006-07	15	916907	668	81787.13	232212.6	708584	1542	89998.47	175399.3
2007-08	15	956810	2055	97609.4	240483.2	830932	2373	133358.1	206855.4
2008-09	15	1003324	2415	102033.9	250793	906429	3973	162631.8	219297.6
2009-10	15	1211031	2368	117569.1	303717.9	1224582	3700	178966.7	297200.3

Table 5.2: Descriptive statistics of outputs (Rs in lakh)

Year	No of firms	Premium				Benefit Paid			
		max	min	Average	SD	max	min	Average	SD
2001-02	12	4982191	28	417453.7	1437523	1747664	3	291325.3	713457.3
2002-03	13	5462849	647	428827.31	1512574.18	2053039	6	158040.1	569376.3
2003-04	13	6316760	2873	509907.3	1744932	2392375	50	184565.9	663364.3
2004-05	14	7512729	174	591820	1992843	2844045	260	221164.2	788082.7
2005-06	15	9079222	2766	705811.7	2319415	3392711	22	251499.1	904259
2006-07	15	12782284	5100	1040384	3255138	5328646	157	371433.4	1371559
2007-08	15	14978999	14349	1341357	3790376	5655033	382	411235.9	1451546
2008-09	15	15728804	20647	1469800	3965317	5247814	618	388911.7	1345301
2009-10	15	18607731	25059	1745930	4685879	7913066	1483	636971.3	2020865

(Note: Firms with its value 0 are excluded from calculation of average and others)

Bajaj's efficiency score has shown an increasing trend till 2005-06 which has thereafter fallen for two years and then increased after 2008-09.Birla's efficiency scored decreased in the year 2008-09 only while Kotak' s efficiency score went down for two years from 2007-08 to 2008-09. HDFC's score went down in 2004-05 and in 2007-08 to 2008-09 as well. ING Vysya has shown an increasing efficiency score throughout the years except a negligible fall in the year 2005-06 and after 2008-09. Sahara has shown a decrease in score in the year 2007-08 while the same

was happened in 2008-09 in case of Shriram. Met has shown a decreasing trend in the years 2006-07 and 2007-08 while max's efficiency score was slightly down in 2007-08 only. Reliance's efficiency score was down for continuous three years from 2006-07 to 2008-09. Tata has shown an increasing trend throughout the year except in the year 2004-05 and 2008-09.

In the year 2001-02, the number of efficient insurers stood at two being LIC and SBI. The lowest efficiency score of the year was 0.052 (Reliance). In the next three years too only SBI and LIC remained efficient. Reliance was the most inefficient insurer in 2002-03, met in 2003-04 while it was Sahara in 2004-05. Three insurers were efficient while Shriram was most inefficient with CRS score of 0.203 in 2005-06.From the year 2006-07 to 2008-09, Met remain most inefficient while only three insurers remain efficient. In 2009-10 too Met has highest inefficiency score of 0.428 while the number of efficient insurers increased to 4.

Table 5.4 represents the efficiency scores (pure technical efficiency) of life insurers calculated at variable returns to scale. In 2001-02 and 2002-03, ICICI was the only insurer with efficiency score above 0.5 but less than 1. In 2003-04, the number increased to three with HDFC and Birla joining the group with efficiency score of 0.509 and 0.516. In the year 2004-05, there were four insurers with VRS efficiency score above 0.5 but less than 1.This year, ICICI joined the group of efficient insurers increasing the number of efficient insurers to three.

Table 5.3: Gross efficiency scores at constant return to scale (CRS) i.e. technical efficiency (TE)

Insurer	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
Lic	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Aviva		0.166	0.195	0.293	0.386	0.428	0.526	0.598	0.763
Bajaj	0.138	0.257	0.285	0.504	0.674	0.487	0.421	0.625	0.697
birla	0.287	0.305	0.516	0.532	0.572	0.588	0.612	0.507	0.623
Hdfc	0.297	0.438	0.509	0.497	0.844	0.908	0.865	0.658	0.783
Icici	0.484	0.559	0.635	0.775	0.990	1.000	1.000	1.000	1.000
ING	0.106	0.108	0.210	0.409	0.402	0.501	0.704	0.596	0.524
Kotak	0.126	0.188	0.384	0.666	0.711	0.821	0.67	0.536	1.000
Met	0.053	0.122	0.179	0.219	0.329	0.313	0.273	0.325	0.428
max	0.182	0.224	0.283	0.304	0.392	0.439	0.436	0.634	0.787
reliance	0.052	0.100	0.238	0.527	1.000	0.677	0.667	0.403	0.749
Sbi	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
tata	0.206	0.288	0.388	0.347	0.439	0.478	0.541	0.522	0.914
sahara				0.151	0.473	0.509	0.443	0.496	0.608
shriram					0.203	0.417	0.507	0.477	0.496
Average	0.328	0.366	0.448	0.516	0.628	0.638	0.644	0.625	0.758

Again in 2005-06 the number of efficient insurers doubled standing at six whiles the number of insurers with efficiency above 0.5 were at four. In the year 2006-07, the number of efficient insurers went down to four but efficiency score above 0.5 went up to seven. In the year 2007-08, there were five efficient insurers. The insurers with efficiency score above 0.5 were eight and so only two insurers have efficiency score below 0.5. Aviva's efficiency score was seen increasing throughout the years. There were 5 efficient insurers in 2008-09 and 2009-10 each.

Table 5.4: Efficiency scores at variable return to scale (VRS) i.e. pure technical efficiency (PTE)

Insurer	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
Lic	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Aviva		0.166	0.195	0.293	0.397	0.440	0.585	0.683	0.783
Bajaj	0.138	0.257	0.285	0.504	0.674	0.688	1.000	1.000	0.699
birla	0.323	0.305	0.516	0.532	0.58	0.596	0.633	0.521	0.630
Hdfc	0.297	0.449	0.509	0.497	0.855	0.911	0.877	0.670	0.825
Icici	0.651	0.887	0.825	1.000	1.000	1.000	1.000	1.000	1.000
ING	0.106	0.108	0.210	0.409	0.414	0.530	0.791	0.718	0.606
Kotak	0.126	0.188	0.384	0.666	0.732	0.86	0.730	0.578	1.000
Met	0.053	0.122	0.179	0.219	0.36	0.341	0.314	0.358	0.453
max	0.202	0.224	0.283	0.304	0.405	0.447	0.461	0.646	0.787
reliance	0.052	0.100	0.238	0.527	1.000	0.704	0.698	0.416	0.751
Sbi	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
tata	0.206	0.288	0.388	0.347	0.446	0.489	0.583	0.573	0.921
sahara				0.151	1.000	1.000	1.000	1.000	1.000
shriram					1.000	0.931	0.762	0.780	0.626
Average	0.346	0.392	0.462	0.532	0.724	0.729	0.762	0.730	0.805

LIC and SBI were efficient throughout the years taken in study with VRS efficiency score of 1. Aviva and Max have shown a consistent increase in efficiency scores over the years. Bajaj's efficiency score has shown an increasing trend except in 2009-10. Birla's efficiency score increased from 2002-03 till 2007-08 but has fallen in the year 2008-09. Kotak's efficiency score went down for two years from 2007-08 to 2008-09. HDFC's score went down in 2004-05 and in 2007-08to 2008-09 as well. ICICI remained efficient from 2004-05 onwards. ING Vysya has shown an increasing efficiency score throughout the years except a negligible fall after 2008-09. Met has shown a decreasing trend in the years 2006-07 and 2007-08 and its efficiency remained less than 0.5 in all years. Reliance's efficiency score was down for continuous three years from 2006-07 to 2008-09. Tata has shown an increasing trend throughout

the year except in the year 2004-05 and 2008-09. Sahara remained efficient throughout the year except in the first year i.e.2004-05. Shriram has shown a decreasing trend in score except a slight improvement in 2008-09.

Table 5.5 is the scale efficiency of life insurers which is the ratio of CRS efficiency score to VRS efficiency score. In the year 2001-02, nine insures out of twelve have scale efficiency of 1 which indicated their operation at most productive scale size. The number of insurers operating at best productive scale was 10 out of 13 in the next year. In 2003-04 and 2004-05, ICICI was the only insurer operating below the best scale of production. In 2005-06 only four insurers were operating at most productive scale while remaining eleven insurers were operating at SE below 1, showing they have scope for improvement in their scale of operation and can therefore improve their efficiency too. There were three insurers at their most productive scale of operation while remaining 12 have scope for improvement in 2006-07, 2007-08 and 2008-09. In 2009-10, 5 insurers were at their best scale of efficiency and 7 out of remaining 10 insurers have scale efficiency above 0.9 which is almost close to best scale of production.

LIC and SBI remained at best productive scale throughout the sample period. Aviva's SE remained above 0.85 but slightly less than 1.Bajaj was operating at best productive scale till 2005-06 but not in the remaining years. Birla and HDFC have SE less than 1 but more than 0.90 from 2005-06 to 2009-10.Their SE before 2005-06 were 1 except in 2001-02 for Birla and 2002-03 for HDFC. ICICI has SE equivalent to 1 from 2006-07 onwards. ING, Met and Tata could have SE of 1 till 2004-05 and till 2005-06 for Reliance. Kotak was at most productive scale of

operation from 2001-02 till 2004-05 and in 2009-10; in between also it remained almost near to best scale of production. Max was at best scale of operation from 2002-03 till 2004-05 and in 2009-10.Sahara was scale efficient in 2004-05 only while Shriram was never operating at productive scale. Their SE was quite low compare to other insurers remaining in between 0.2 to 0.7.

Table 5.5: Scale efficiency scores of the companies

Insurer	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
Lic	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Aviva		1.000	1.000	1.000	0.972	0.973	0.899	0.876	0.974
Bajaj	1.000	1.000	1.000	1.000	1.000	0.708	0.421	0.625	0.997
birla	0.889	1.000	1.000	1.000	0.986	0.987	0.967	0.973	0.989
Hdfc	1.000	0.975	1.000	1.000	0.987	0.996	0.986	0.982	0.949
Icici	0.743	0.630	0.770	0.775	0.990	1.000	1.000	1.000	1.000
ING	1.000	1.000	1.000	1.000	0.971	0.945	0.890	0.830	0.865
Kotak	1.000	1.000	1.000	1.000	0.971	0.955	0.918	0.927	1.000
Met	1.000	1.000	1.000	1.000	0.914	0.918	0.869	0.908	0.945
max	0.901	1.000	1.000	1.000	0.968	0.982	0.946	0.981	1.000
reliance	1.000	1.000	1.000	1.000	1.000	0.962	0.956	0.969	0.997
Sbi	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
tata	1.000	1.000	1.000	1.000	0.984	0.978	0.928	0.911	0.992
sahara				1.000	0.473	0.509	0.443	0.496	0.608
shriram					0.203	0.448	0.665	0.612	0.792
Average	0.961	0.970	0.982	0.984	0.895	0.891	0.859	0.873	0.941

Table 5.6 shows the efficiency scores of life insurance firms viz. CRS VRS and Scale efficiency. For the year 2001-02, the efficiency scores of 12 life insurers are given in table 5.6. LIC and SBI have efficiency score of 1 for both the efficiency frontiers viz. CRS, VRS and therefore has SE of 1. This indicated that both the insurers were efficient and operating at the most productive scale size. The remaining 11 companies were inefficient as their efficiency scores are less than 1 for

both CRS and VRS assumption. However except three insurers, viz. Birla, ICICI and Max, remaining six insurers have scale efficiency of 1. This indicated that these six insurers were inefficient even though operating at their most productive scale size while the remaining four has scope for efficiency improvement if operated at most productive scale size. Of the 12 insurers Reliance has lowest efficiency score of 0.52 in both CRS and VRS.

For the year 2002-03 with 13 insurers taken, LIC and SBI have efficiency scores of 1. All the insurers except HDFC and ICICI have scale efficiency slightly less than 1 which indicated their operation at their best productive scale. Among the insurers ICICI was the only insurer with its efficiency score both in CRS and VRS more than 0.5 but less than 1.Reliance was lowest in efficiency score with 0.1.

In the year 2003-04 given in Table 5.6, of all the 13 insurers taken together, only ICICI have shown scale efficiency less than 1. ICICI with scale efficiency of 0.770 and gross efficiency of 0.635 and 0.825 at CRS and VRS respectively showed a scope for improvement in efficiency.LIC and SBI stood most efficient this year too and next to them were Birla, HDFC and ICICI with efficiency scores above 0.50.The remaining insurers can be termed as highly inefficient as their efficiency is below 0.50 even at operating in their most productive scale with scale efficiency of 1. Met scored lowest rank in efficiency with only 0.179 for both CRS and VRS.

Table 5.6: Year-wise CRS, VRS and SE of Insurers

	2001-02			2002-03			2003-04		
company	CRS	VRS	SE	CRS	VRS	SE	CRS	VRS	SE
Lic	1	1	1	1	1	1	1	1	1
Aviva				0.166	0.166	1	0.195	0.195	1
Bajaj	0.138	0.138	1	0.257	0.257	1	0.285	0.285	1
birla	0.287	0.323	0.889	0.305	0.305	1	0.516	0.516	1
Hdfc	0.297	0.297	1	0.438	0.449	0.975	0.509	0.509	1
Icici	0.484	0.651	0.743	0.559	0.887	0.630	0.635	0.825	0.770
ING	0.106	0.106	1	0.108	0.108	1	0.21	0.21	1
Kotak	0.126	0.126	1	0.188	0.188	1	0.384	0.384	1
Met	0.053	0.053	1	0.122	0.122	1	0.179	0.179	1
max	0.182	0.202	0.901	0.224	0.224	1	0.283	0.283	1
reliance	0.052	0.052	1	0.1	0.1	1	0.238	0.238	1
Sbi	1	1	1	1	1	1	1	1	1
tata	0.206	0.206	1	0.288	0.288	1	0.388	0.388	1
sahara									
shriram									

	2004-05			2005-06			2006-07		
company	CRS	VRS	SE	CRS	VRS	SE	CRS	VRS	SE
Lic	1	1	1	1	1	1	1	1	1
Aviva	0.293	0.293	1	0.386	0.397	0.972	0.428	0.44	0.973
Bajaj	0.504	0.504	1	0.674	0.674	1	0.487	0.688	0.708
birla	0.532	0.532	1	0.572	0.58	0.986	0.588	0.596	0.987
Hdfc	0.497	0.497	1	0.844	0.855	0.987	0.908	0.9113	0.996
Icici	0.775	1	0.775	0.990	1	0.990	1	1	1
ING	0.409	0.409	1	0.402	0.414	0.971	0.501	0.53	0.945
Kotak	0.666	0.666	1	0.711	0.732	0.971	0.821	0.86	0.955
Met	0.219	0.219	1	0.329	0.36	0.914	0.313	0.341	0.918
max	0.304	0.304	1	0.392	0.405	0.968	0.439	0.447	0.982
reliance	0.527	0.527	1	1	1	1	0.677	0.704	0.962
Sbi	1	1	1	1	1	1	1	1	1
tata	0.347	0.347	1	0.439	0.446	0.984	0.478	0.489	0.978
sahara	0.151	0.151	1	0.473	1	0.473	0.509	1	0.509
shriram				0.203	1	0.203	0.417	0.931	0.448

Table 5.6 continue

	2007-08			2008-09			2009-10		
company	CRS	VRS	SE	CRS	VRS	SE	CRS	VRS	SE
Lic	1	1	1	1	1	1.000	1	1	1.000
Aviva	0.526	0.585	0.899	0.598	0.683	0.876	0.763	0.783	0.974
Bajaj	0.421	1	0.421	0.625	1	0.625	0.697	0.699	0.997
birla	0.612	0.633	0.967	0.507	0.521	0.973	0.623	0.63	0.989
Hdfc	0.865	0.877	0.986	0.658	0.67	0.982	0.783	0.825	0.949
Icici	1	1	1	1	1	1.000	1	1	1.000
ING	0.704	0.791	0.890	0.596	0.718	0.830	0.524	0.606	0.865
Kotak	0.67	0.73	0.918	0.536	0.578	0.927	1	1	1.000
Met	0.273	0.314	0.869	0.325	0.358	0.908	0.428	0.453	0.945
max	0.436	0.461	0.946	0.634	0.646	0.981	0.787	0.787	1.000
reliance	0.667	0.698	0.956	0.403	0.416	0.969	0.749	0.751	0.997
Sbi	1	1	1	1	1	1.000	1	1	1.000
tata	0.541	0.583	0.928	0.522	0.573	0.911	0.914	0.921	0.992
sahara	0.443	1	0.443	0.496	1	0.496	0.608	1	0.608
shriram	0.507	0.762	0.665	0.477	0.78	0.612	0.496	0.626	0.792

As in table 5.6, 14 life insurers were taken in the year 2004-05.Of them, ICICI was the only insurer which was not operating at its most productive scale size with scale efficiency of 0.775.It therefore has scope for improvement in CRS efficiency score if operated at best scale of operation. This was supported by the fact that ICICI has efficiency score of 1 at variable return to scale. Bajaj, Birla, Kotak and Reliance have shown efficiency scores above 0.50 at their best productive scale of operation.LIC and SBI still stood most efficient this year too. The newly entrant Sahara was the most inefficient among the insurers taken with gross efficiency score of 0.151 for both CRS and VRS.

In the year 2005-06 in addition to LIC and SBI having efficiency score of 1 each in CRS and VRS at their most productive scale, Reliance has also joined the group. Of the 15 insurers taken together, no insurers except Aviva and above three efficient insurers were operating at their best scale of production. Sahara and Shriram are operating at a very low

scale efficiency which was less than 0.5.However their VRS efficiency scores stood at 1 though Shriram has lowest CRS efficiency score of 0.203. The remaining insurers were operating at SE which was very near to most productive scale size with above 0.9. Bajaj, Birla, HDFC, ICICI and Kotak have CRS efficiency scores more than 0.5 and their VRS efficiency scores were also more than 0.5 with ICICI touching 1.

In 2006-07, of the 15 insurers LIC, SBI and ICICI were most efficient at their best scale of operation. On an average, the insurers were operating very near to their most productive scale of operation. Aviva, Met, Tata and Max were among the inefficient insurers scoring less than 0.5 in both CRS and VRS. Shriram and Bajaj scored CRS efficiency less than 0.5 but their VRS efficiency scores stood more than 0.5.

In 2007-08 too, LIC, SBI and ICICI were most efficient at their best scale of operation. Met stood lowermost in efficiency ranking for both CRS and VRS with 0.273 and 0.314respectively, even at its scale efficiency of 0.869. Bajaj and Sahara's scale efficiency were below 0.5 but very interestingly have VRS efficiency of 1 each. Other insurers were above 0.8 in SE which was very near to 1. On an average, insurers have efficiency scores of more than 0.5.

In 2008-09, LIC, ICICI and SBI were the best insurers with CRS VRS and SE standing each at 1. Bajaj and Sahara have VRS efficiency of 1 each. This year too, Met remained the lowermost scorer of CRS and VRS efficiency; however Sahara did have lowest SE with 0.496.

In case of 2009-10, in addition to the three efficient insurers viz. , LIC, ICICI and SBI, Kotak was seen having jumped into the league of

efficient insurer from all the tree dimensions. In fact this year except three insurers viz. ING, Sahara and Shriram, all other remaining insurers have SE above 0.9. Met had continued to be lowest scorer of CRS as well as VRS efficiency.

Table 5.7: Number of insurers by level VRS efficiency

VRS	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
No.of firms	12	13	13	14	15	15	15	15	15
eff> 0.90	3	2	2	3	6	6	5	5	6
eff>0.75	0	1	1	1	1	1	2	1	4
0.75>eff> 0.60	0	0	0	0	1	2	4	4	4
.60>eff>.45	0	0	2	3	1	3	3	3	1
.45>eff	9	10	8	7	6	3	1	2	0

Table 5.8: Number of insurers by level of scale efficiency

SE	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
No.of firms	12	13	13	14	15	15	15	15	15
eff> 0.90	9	12	12	13	13	12	9	10	12
eff>0.75	0	0	0	0	0	0	3	2	2
0.75>eff> 0.60	1	1	1	1	0	1	1	2	1
.60>eff>.45	1	0	0	0	1	1		1	0
.45>eff	1	0	0	0	1	1	2	0	0

(Note-CRS=Constant Return to Scale. VRS=Variable Return to Scale. SE= Scale Efficiency=CRS/VRS)

The average efficiency in case of CRS, the average was found to be increasing over the years from 0.328 in 2001-02 to 0.758 in 2009-10 but slightly decreased in 2008-09. For VRS also the efficiency was increasing over the years except a slight fall in 2002-03.The average scale efficiency however keep fluctuating over the years. In fact it was lowest in 2007-08.

Table 5.9: Number of insurers by level of CRS efficiency

CRS	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
No.of firms	12	13	13	14	15	15	15	15	15
eff> 0.90	2	2	2	2	4	4	3	3	5
eff>0.75	0	0	0	1	1	1	1	0	3
0.75>eff> 0.60	0	0	1	1	2	1	4	3	4
.60>eff>.45	1	1	2	4	2	5	3	7	2
.45>eff	9	10	8	6	6	4	4	2	1

Table 5.7, 5.8 and 5.9 are year wise number of insurers dividing them in 5 different groups according to their VRS, SE and CRS efficiency scores. Number of insurers with efficiency more than 0.90 was increased from 3 in 2001-02 to 6 in 2009-10 for VRS, 9 to 12 insurers in case of SE while 2 to 5 insurers in case of the CRS. Though almost all the insurers were earlier in the group of efficiency less than 0.45 categories it decreased over the years. In 2009-10 no insurer was included in this group for VRS while only 1 insurer remained in the group for CRS. For VRS, it can be seen that insurers started falling in the category of efficiency score 0.6 to 0.75 from the years 2006-07 onwards.

5.1.4-Main Points:

The efficiency scores of 15 Indian life insurers have been estimated from the year 2001-02 to 2009-10. SBI and LIC were the only two insurers who remain efficient throughout the years, in terms of CRS VRS and SE. As far as the average efficiency score of the industry was concerned, VRS efficiency has doubled from 0.418 in 2001-02 to 0.805 in 2009-10. In case of CRS too; the average Efficiency scores has doubled from 0.328 in 2001-02 to 0.758 in 2009-10 and this is a very

healthy sign. Two-third of insurers has got SE more than 0.90 which was almost near to 1. Thus it showed that liberalization has contributed in efficiency gains of firms over the years.

5.2: PRODUCTIVITY

5.2.1-Concepts:

A firm or industry is considered to be inefficient if it could produce more output with existing inputs, i.e. the firm is not on the production possibility curve, but within it. Productivity relates the quantity of output produced to one or more inputs used in its production, irrespective of the efficiency of their use. Productivity describes the relationship between output and the input that are required to generate that output. Productivity without efficiency is usually very expensive. Efficiency does not always lead to productivity. Productivity is equated with technological change and is measured as favorable shift in the production function. Productivity changes are often defined in terms of Total factor productivity. The TFP measures the change in outputs that are not attributable to change in input. According to Coelli et al (1998), TFP is the overall productivity measure that encompasses the productivity of all production factors or outputs. TFP gains include effects of technical change, economies of scale, capacity utilization, market inefficiency, qualitative changes in inputs and X-efficiency. These non input factors make the input factors more productive, hence enabling more production with the same quantity of inputs. There are three main approaches to measure TFP viz. Growth accounting (index number) approach, econometric approach and Frontier model approach. The Index approach is based on the indices of output and inputs. Indices are made under the implicit assumption of a particular production function. In

econometric approach, the production function or its dual in the form of cost or profit function is explicitly estimated. It aims at deriving the different components of productivity from the parameter estimated by fitting the function. The frontier model studies how far a decision making unit is from the efficiency frontier. Efficiency Frontier can further be studied either through econometric approach (EA) or non parametric approach (PA). EA uses parametric representation of technology along with a two part composed error term. One part of the error term represents statistical noise and is generally assumed to follow a normal distribution. The other part represents inefficiency and is assumed to follow a particular one sided distribution. The non parametric approach uses mathematical programming known as DEA. It uses linear programming method to estimate the efficiency frontier to evaluate the relative efficiency of a firm or organization.

5.2.2-Methodology:

Productivity improvement is critical for life insurers facing increasing competition in the aftermath of insurance liberalization in India. Productivity growth over time, where productivity growth is defined as the change in output due to technical efficiency change and technical change over time (Grosskopf, 1993, and Fare, et al., 1994) is measured and to measure efficiency change and technical change, the Malmquist index approach (Grifell-Tatjé and Lovell, 1993, Färe, et al., 1994), (DEA- based methodology) is adopted. The firm level data of 9 years is considered from the year 2001-02 to 2009-10.The number of firms taken varied from 12 to 15.

Malmquist Productivity Index (MPI):

Malmquist Productivity Index (MPI) is a nonparametric model, which is derived from Data Envelopment Analysis (DEA). It is a bilateral index that can be used to compare the production technology of two economies. MPI makes use of distance functions to measure productivity change. Distance functions describe a multi-input, multi output production technology without the need to specify a behavioral objective (such as cost minimization or profit maximization). It can be defined using input or output orientated distance functions. This approach was first proposed by Caves, Christensen and Diewert (1982) and named it after Malmquist (1953), who proposed to construct quantity indices as ratio of distance functions for use in consumption analysis. An input distance function characterizes the production technology by looking at a maximal proportional contraction of the input vector, given an output vector. An output distance function considers a maximal proportional expansion of the output vector, given an input vector.

The MPI or the total factor productivity (TFP) calculated in this study measures the change in the production frontier and how the current frontier relates to the firms' frontiers over time. The growth in TFP has two major components: technological change and efficiency change. Technological change is represented by a shift in the production frontier while efficiency change is based upon an index of a firm's efficiency relative to past and future frontiers.

Distance functions can be used to compare the firm's efficiencies in periods t and t+1. The input distance function is the same as the reciprocal of the minimum equi-proportional contraction of the input

vector x, given outputs y, i.e. Farrell's (1957) measure of input technical efficiency. Input technical efficiency TE(x,y) is therefore defined as

$$TE(x,y) = \frac{1}{D(x,y)}$$

TE(x,y) for each decision making unit can be obtained by linear programming (Charnes, et al., 1994). To provide some intuition into the interpretation of the input distance function, consider the single output, single input frontier portrayed in Figure 1in the appendix. The lines V^t and V^{t+1} represent the production frontiers in periods t and t+1, respectively. The boundary V^t represents the minimum inputs needed to produce any given level of output in period t. Thus, input-output combinations observed among firms in period t lie on or to the right of V^t. Firms on the frontier are considered fully efficient; while those to the right of V^t are inefficient. The type of efficiency considered here is technical efficiency, i.e., firms on the frontier are using the most efficient available technology, while those to the right of the frontier are not using this technology. To illustrate the distance function, consider a firm operating at point (x^t, y^t), where x^t and y^t represent, respectively, the firm's input and output in period t. The firm's input quantity x^t is represented by the distance 0e along the horizontal axis. By adopting the most efficient technology, this firm could operate on the frontier, using input quantity 0b. The value of the input distance function for this firm is equal to 0e/0b, and its Farrell technical efficiency ratio is the reciprocal 0b/0e. The input distance function value, $D(x^t, y^t) = 0e/0b \geq 1$, while its Farrell technical efficiency, $TE = 0b/0e \leq 1$.

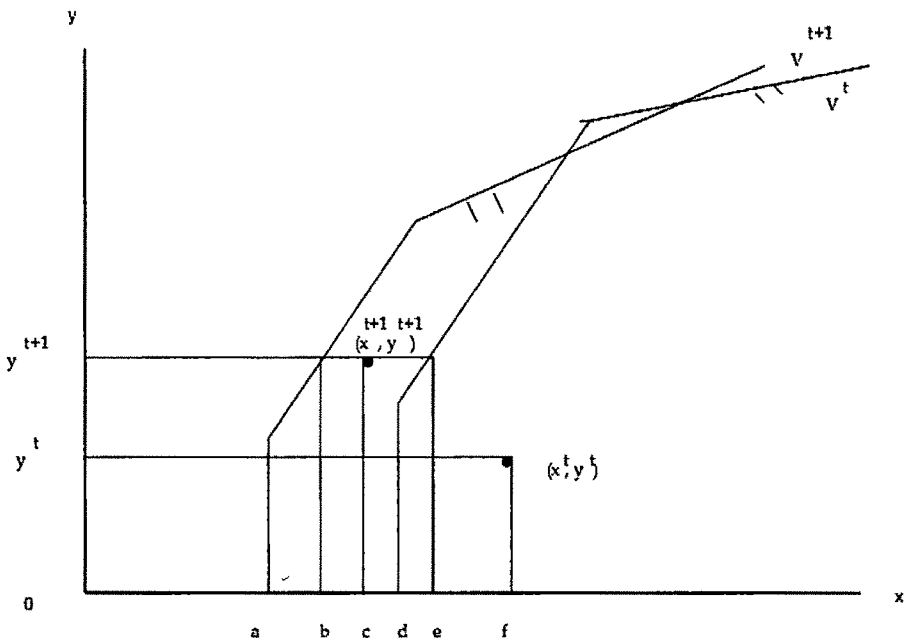

Fig-5.2-Malmquist Index of TFP (Input based) and Input distance Functions.

If technology is improving over time, we will observe shifts in the frontier. For example, in Figure 5.2, the frontier labeled V^{t+1} represents the frontier in period t+1. The improved technology represented by V^{t+1} enables efficient firms to produce all levels of output using less of the input than was required by technology V^{t}. For example, suppose that our hypothetical firm has input-output combination (x^{t+1}, y^{t+1}) in period t+1. Because of technical progress, this firm operates to the left of V^{t}, i.e., its input-output combination would have been infeasible using period t technology, but is feasible using period t+1 technology. This firm is also more efficient relative to the period t+1 frontier than it was relative to the period t frontier, because its operating point is closer to the frontier in t+1. In distance function terms, $D^{t+1}(x^{t+1},y^{t+1}) = 0d/oc < D^{t}(x^{t},y^{t}) = 0e/0b$, where superscripts on D indicate the time period of the frontier from

which the distance is computed. Distance functions are estimated by solving linear programming problems. For example, the distance function is obtained by solving the following linear programming model, for each firm, i = 1, 2... I, for each year of the sample period (time superscripts are suppressed):

$$(D(x_i, y_i))^{-1} = TE(x_i, y_i)$$

$$= \min \theta_i$$

$$\textit{subject to:} \quad Y\lambda_i \geq Y_i$$

$$X\lambda_i \leq \theta_i X_i$$

$$\lambda_i \geq 0$$

where X is an K x I input matrix and Y an N x I output matrix for all sample firms, X^i is a K x 1 input vector and Y^i an N x 1 output vector of firm i, and λ_i is an I x 1 intensity vector (the inequalities are interpreted as applying to each row of the relevant matrix).

The distance function representation is used to define the Malmquist index of total factor productivity. To determine whether productivity change has occurred between periods t and t+1, either the period t frontier or the period t+1 frontier can be used as point of reference. With respect to the period t frontier, an input-oriented Malmquist productivity index can be defined as:

$$M^t = \frac{D^t(x^t, y^t)}{D^t(x^{t+1}, y^{t+1})}$$

The input oriented Malmquist productivity index for the period t+1 frontier is defined by

$$M^{t+1} = \frac{D^{t+1}(x^t, y^t)}{D^{t+1}(x^{t+1}, y^{t+1})}$$

Where, M^t measures productivity growth between periods t and t+1 using the technology in period t as the reference technology while, M^{t+1} measures the productivity growth with respect to the technology in period t+1. To avoid an arbitrary choice of reference technology, the input-oriented Malmquist productivity index is defined as the geometric mean of M^t and M^{t+1} (Färe, et al., 1994)

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\left(\frac{D^t(x^t, y^t)}{D^t(x^{t+1}, y^{t+1})}\right)\left(\frac{D^{t+1}(x^t, y^t)}{D^{t+1}(x^{t+1}, y^{t+1})}\right)\right]^{\frac{1}{2}}.$$

This productivity index can be decomposed into measures of technical efficiency change and technical change, by factoring as follows:

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = \left(\frac{D^t(x^t, y^t)}{D^{t+1}(x^{t+1}, y^{t+1})}\right)\left[\left(\frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^t(x^{t+1}, y^{t+1})}\right)\left(\frac{D^{t+1}(x^t, y^t)}{D^t(x^t, y^t)}\right)\right]^{\frac{1}{2}}$$

(Note-This Malmquist productivity index is input-oriented so, the numerator and denominator are reversed compared with those in Fare et al. (1994), in which they use output-oriented Malmquist index.)

The first ratio in equation above, in parentheses, represents technical efficiency change, i.e., the relative distance of the input-output bundle from the frontier in period t and t+1. It can be noted here that both the numerator and denominator of the ratio must be greater than or equal to 1 and that values closer to 1 represent higher efficiency. Thus, if technical efficiency is higher in period t+1 than in period t, the value of this ratio will be > 1; while if efficiency declines between the two periods, the value of the ratio will be < 1

The second factor in equation above is a geometric mean, representing technical change (shifts in the frontier) between period t and t+1. If technical improvement occurs, both ratios comprising the geometric mean will exceed 1. Thus, values of the second factor > 1 imply technical progress and values < 1 imply technical regress.

The distance functions $D^{t}(x^{t}, y^{t})$, $D^{t}(x^{t+1}, y^{t+1})$, $D^{t+1}(x^{t}, y^{t})$ and $D^{t+1}(x^{t+1}, y^{t+1})$ are measured by solving mathematical programming problems. So In order to measure the Malmquist TFP change for the i th firm, between two adjacent periods four distance functions are calculated. This requires the solving of four linear programming (LP) problems.

The required LP problems under the assumption of a CRS technology are:

(1)

$$(D(x_i, y_i))^{-1} = TE(x_i, y_i)$$

$$= \min \theta_i$$

$$\textit{subject to:} \quad Y\lambda_i \geq Y_i$$

$$X\lambda_i \leq \theta_i X_i$$

$$\lambda_i \geq 0$$

Where , $D^t(x_i^t, y_i^t)$ is the distance of the time t input-output bundle from the time t frontier for the firm I i.e it is distance function measuring the efficiency of conversion of input x^t to output y^t at the period t

(2)

$$(D^{t+1}(x_i^t, y_i^t))^{-1} = \min \theta_i$$

$$\textit{subject to:} \quad Y^{t+1}\lambda_i \geq Y_i^t$$

$$X^{t+1}\lambda_i \leq \theta_i X_i^t$$

$$\lambda_i \geq 0, \quad e^T\lambda_i \geq 0$$

Where , $D^{t+1}(x_i^t, y_i^t)$ is the distance of the time t input-output bundle from the time t+1 frontier for the firm i.

(3)

$$(D^{t+1}(x_i^{t+1} \; y_i^{t+1}))^{-1} = \min \theta_i$$

$$\textit{subject to} \quad Y^{t+1}\lambda_i \geq y_i^{t+1},$$

$$X^{t+1} \; \lambda_i \leq \theta_i x_i^{t+1}$$

$$\lambda_i \geq 0, \; \theta_{0\,free},$$

(4)

$$(D^{t}(x_i^{t+1}\ y_i^{t+1}))^{-1} = \min \theta_i$$

$$\textit{subject to}\ \ Y^{t}\lambda_i \geq y_i^{t+1},$$

$$X^{t}\ \lambda_i \leq \theta_i x_i^{t+1}$$

$$\lambda_i \geq 0,\ \theta_{0\,free},$$

Table 5.10: Malmquist productivity index (MPI) of the insurers

	MPI								Company average
company	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	
Lic	1.050	0.961	0.953	0.883	0.834	0.996	1.014	0.955	0.96
Aviva		1.257	0.870	1.165	0.982	0.917	0.771	0.842	0.97
Bajaj	0.688	0.978	0.953	0.872	0.797	0.819	0.961	1.204	0.91
birla	0.731	0.980	0.912	0.994	0.867	0.931	0.896	1.144	0.93
Hdfc	0.763	0.979	2.062	1.239	1.020	0.919	0.856	1.253	1.14
Icici	0.747	0.978	0.887	0.990	1.014	0.970	0.652	0.784	0.88
ING	0.978	1.115	0.869	1.258	1.017	0.934	0.720	0.820	0.96
Kotak	0.708	1.074	0.874	1.144	0.987	0.904	0.845	1.042	0.95
Met	28.263	30.352	26.360	38.921	1.004	0.930	0.921	0.940	0.95
max	0.708	0.977	0.872	1.091	0.943	0.925	0.970	0.867	0.92
reliance	1.302	1.468	0.929	1.640	1.042	0.865	0.800	1.070	1.14
Sbi	1.115	1.258	0.922	1.372	0.977	0.859	1.011	0.857	1.05
tata	0.737	0.978	0.893	1.079	0.853	0.922	0.790	1.122	0.92
sahara				1.160	1.007	0.919	0.949	0.976	1.00
shriram					0.890	0.955	0.971	0.962	0.94
Total Average	***0.87***	***1.08***	***1.00***	***1.15***	***0.95***	***0.92***	***0.88***	***0.99***	***0.98***

(Note: The MPI of Met is not considered for the years from 2001-02 to 2005-06 in average calculation as its MPI is abnormally high and so may affect the overall average. The same is considered for TEC and TC also.)

Table 5.10 shows the MPI index of 15 life insurers from the year 2002-03 to 2009-10. The Malmquist results for 2002-03 would mean the change in productivity from 2001-02 to 2002-03. The 2006-07's Malmquist index

(0.834) showed a decline in productivity of about 16.6 percent ((1 minus 0.834) times 100) for LIC which was the highest decline of the company in 8 years taken. The company on an average have 4% decline in productivity in 8 years. Aviva's and Max's MPI improved only in 2005-06 while Bajaj and Birla in 2009-10 only. HDFC, SBI, Reliance and Sahara are the four insurers whose average productivity has improved over the years. ICICI's MPI improve only in 2006-07 while Shriram's MPI never improved. ICICI showed highest average productivity decline of 12 percent while HDFC and Reliance showed highest average improvement of productivity with 14 percent. The Malmquist indices of the industry total showed improvement in productivity in only three of the eight two-year comparisons and productivity regress in five of the eight comparisons.

Table 5.11: MPI decomposed into technical efficiency change (TEC) and technical change (TC)

Company	2002-03		2003-04		2004-05		2005-06	
	TEC	TC	TEC	TC	TEC	TC	TEC	TC
Lic	1.000	1.05	1.000	0.961	1.000	0.953	1.000	0.883
Aviva	--	--	1.175	1.070	1.503	0.579	1.317	0.884
Bajaj	1.862	0.370	1.109	0.882	1.768	0.539	1.337	0.652
birla	1.063	0.688	1.692	0.579	1.031	0.885	1.075	0.925
Hdfc	1.475	0.518	1.162	0.842	0.976	2.112	1.698	0.730
Icici	1.155	0.647	1.136	0.861	1.220	0.727	1.277	0.775
ING	1.019	0.695	1.944	0.573	1.948	0.446	0.983	1.280
Kotak	1.492	0.511	2.043	0.526	1.734	0.504	1.099	1.041
Met	2.302	12.278	1.467	20.687	1.223	21.546	1.502	25.908
max	1.231	0.576	1.263	0.773	1.074	0.811	1.289	0.846
reliance	1.923	0.677	2.380	0.617	2.214	0.420	1.865	0.865
Sbi	1.000	1.115	1.000	1.258	1.000	0.922	1.000	1.372
tata	1.390	0.527	1.347	0.726	0.894	0.998	1.265	0.853
sahara							3.132	0.370
Total Average	**1.328**	**0.67**	**1.438**	**0.806**	**1.364**	**0.825**	**1.411**	**0.883**

Table 5.11 continues.

Company	MPI decomposed								Company average	
	2006-07		2007-08		2008-09		2009-10			
	TEC	TC	TEC	TC	TEC	TC	TEC	TC	TEC	TC
Lic	1.000	0.835	1.000	0.996	1.000	1.014	1.000	0.955	1.00	0.96
Aviva	1.109	0.885	1.229	0.746	1.137	0.678	0.627	0.660	1.25	0.79
Bajaj	0.722	1.103	0.864	0.947	1.485	0.648	1.115	1.080	1.31	0.78
birla	1.028	0.844	1.041	0.895	0.828	1.082	1.229	0.931	1.12	0.85
Hdfc	1.076	0.948	0.953	0.965	0.761	1.125	1.190	1.105	1.16	1.04
Icici	1.010	1.004	1.000	0.970	1.000	0.652	1.000	0.784	1.10	0.80
ING	1.246	0.816	1.405	0.665	0.847	0.850	0.879	0.933	1.28	0.78
Kotak	1.154	0.855	0.816	1.108	0.800	1.057	1.866	0.558	1.38	0.77
Met	0.951	1.055	0.872	1.066	1.190	0.774	1.317	0.713	1.08	0.90
max	1.120	0.842	0.993	0.931	1.454	0.666	1.241	0.698	1.21	0.77
reliance	0.677	1.540	0.985	0.878	0.604	1.324	1.859	0.575	1.56	0.86
Sbi	1.000	0.977	1.000	0.859	1.000	1.011	1.000	0.857	1.00	1.05
tata	1.089	0.784	1.132	0.814	0.965	0.818	1.751	0.641	1.23	0.77
sahara	1.076	0.936	0.870	1.055	1.120	0.848	1.226	0.796	1.48	0.80
shriram	2.054	0.433	1.216	0.785	0.941	1.032	1.040	0.925	1.31	0.79
Total Average	**1.087**	**0.924**	**1.025**	**0.912**	**1.009**	**0.905**	**1.223**	**0.814**	***1.24***	***0.85***

Table 5.11: The technical efficiency change and technical change results for each year from 2002-03 to 2009-10 are given in table 5.2.2. For LIC, the decline in productivity was mainly due to technical regress as its efficiency remained 1 in all the years. The productivity of the year 2002-03 and 2008-09 were improved because, its technology progressed i.e. more than 1 in those two years. Aviva's efficiency was improving all the years except in 2009-10(0.6271<1) but technically regressing throughout. ICICI's efficiency improved all the years but experienced no technical progress in all the years. Kotak showed technical progress in 2007-08 and 2008-09 while ING in 2005-06 though their TECs were declined. SBI showed technical progress in four out of eight years and also maintained efficiency of 1 in all the years. Like SBI, LIC could maintain efficiency of 1 in all years including those two years of technical progress. However no other insurers could simultaneously experienced efficiency as well as technical progress at a time.

5.2.4-Main Points:

This chapter estimated the MPI and it two components, technical efficiency change (TEC) as well as technical change (TC). Out of the 15 insurers, only 4 insurers could have improved average productivity. In 2007-08 no insurers could make productivity improvement. At start, i.e. in 2002-03 and 2003-04, all the insurers showed efficiency improvement which was slightly declined in the next two years and it grew in 2007-08 and 2008-09. However in 2009-10, 14 out of 15 insurers showed efficiency improvement. In a given year, insurers either improve efficiency and regressed technology or decline efficiency and progress technology except SBI and LIC who maintain efficiency with technical progress.