Chapter 1
Introduction and Research Design of the Study

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Chapter 1

Introduction and Research Design of the study

1.1 Introduction

Insurance industry is an important and integral component of macro economy and emerges as a dominant institutional player in financial market impacting the health of economy through its multidimensional role in saving and capital market. It acts as a financial intermediary, a booster of investment activities, a stabilizer of financial market and a risk administrator. The life insurance industry assumes an impressive role in rendering risk cover for individuals. The non-life insurance sector imparts risk cover for assets. Health insurance covers insured medical and surgical expenditures. Pension insurance provides financial support to the insured person and the insured person’s dependents by means of the payment of pension benefits on retirement or permanent incapacitation. India as the second-most populous country in the world provides huge potential for insurance.

The activities of insurance companies encompass underwriting insurance policies and investing the accumulated funds and managing the portfolios. Investment management seems to be a compelling need for both life and non-life insurers. The basic purpose of insurance business is to shield long term funds from the menacing shadow of risks because insurers accumulate substantial funds in conducting their business (Kumar & Ramakrishnan, 2012; Naidu & Suryanarayana, 2015). Insurers collect huge funds because of the duration gap between receipt of premiums and settlement of claims. For many insurers, the spread between the return on investments and the interest expenses of insurance liabilities is the main source of income (Nissim, 2010).

In all the cases, the insurers collect premiums from individuals when selling contracts and invest the proceeds in varied instruments such as government securities, debenture, money market securities, equities, mutual funds and others with a view to meet the contractual obligations incurred in the future. Therefore, the main challenge for insurance companies is not only developing and promoting insurance products, but also the efficient allocation of internal and accumulated funds. The efficiency of an insurance company, its competitive position in the market and the growth of its market value rely upon insurance company’s investment activity. Insurance
companies invest their shareholder’s funds, policyholder’s fund and other financial resources which have valuable contribution to firms as well as to economy. Insurance investments are oiling the wheels of economic and social development of the nation. Insurance investments provide long-term funds to the government and various industries for infrastructure strengthening and other development programmes.

The return on investment of insurance funds influences the premium rates and bonuses of insurance business and eventually, the buying behaviour of customers. Thus, the rate of return offered by insurance companies has a direct bearing on the growth rate of insurance industry and its competitive position especially in a country like India where persistently high inflationary trends have skewed expectations of yields. A number of questions are raised about investment pattern of insurance companies i.e., how insurance companies are investing, where they are investing, how safe policyholder’s funds are, and what is the role of regulations in nurturing the investment of insurance companies. Therefore, this is not logical to leave investment decision on market forces and prudence of insurers. Allocation of funds for investment by insurance companies is regulated in most of countries. Any endeavor in reforming the investment norms is directly related to the growth and development of the insurance sector in any country (Vaidyanathan & Sriram, 2000).

There are two approaches to portfolio regulation namely “prudent- man approach” and “quantitative approach or prescriptive model” (Bijapur, Croci, & Zaidi, 2012; Davis, 2002; Pasiouras & Gaganis, 2013; Vaidyanathan & Sriram, 2000). Unlike the prescriptive model or quantitative approach, prudent man rule do not prescribe any mandate investment pattern, but specifies that the minimum solvency must be backed by “Eligible assets” and “Admissibility limits” in making asset allocation decisions (Vaidyanathan & Sriram, 2000). These approaches are not polar opposites, but there are certain gradations between two. Both approaches are sought to ensure adequate portfolio diversification and liquidity of the asset portfolio, but in radically different ways (Davis, 2002). At present, insurance companies in India are subjected to quantitative model. A very first time in the history of insurance companies’ investment, Insurance Act, 1938 formally regulates the investment pattern of insurance companies where insurance companies have to comply with the section 27, 27A and 27B. In 1994, Malhotra committee recommended certain amendment to Life Insurance Corporation of India Act 1956, General Insurance Business

Investment pattern of insurance companies is not only regulated by sections of The Insurance Act, Life Insurance Corporation of India Act, General Insurance Business Nationalization Act, Insurance Regulatory and Development Authority of India (Investment) Regulations; but also by various provisions of The Securities and Exchange Board of India (SEBI), The Fixed Income Money Market and Derivatives Association of India (FIMMDA), The Reserve Bank of India (RBI), Companies Act and guidelines of government in this regard. In addition to these, the specifications made in “Technical Guidelines for Concurrent Audit and Certification on Investment Risk Management System and Process of Insurance Companies” issued by The Institute of Chartered Accountant of India (ICAI) also required to be followed.

Insurance companies invest large portion of their fund in fixed income securities (Bank for International Settlement, 2011a). The fixed income securities mainly consist of government securities and AAA or AA+ rated bonds. Investments of insurance companies have been valued according to the provisions of the Insurance Act, 1938 and the regulations/directions issued by IRDAI in this behalf. All debt securities including government securities and redeemable preference shares are considered as ‘held to maturity’ and accordingly measured at historical cost, subject to amortization of premium or accretion of discount in the Revenue account or the Profit and Loss account over the period of maturity/ holding on a straight line basis. Listed equity shares and mutual fund investments are measured at fair value and Investment in real estate is valued at historical cost, subject to revaluation (at least once in every three years). A similar method of measuring shareholders’ investment is also prescribed under regulation.
IRDAI has prescribed quantitative limits on investment pattern of insurance companies. According to Insurance Regulatory and Development Authority of India (Investment) (Fifth Amendment) Regulation, 2013, the quantitative limits of:

Life Fund: A minimum of 25% is to be invested in central government securities. A minimum of 50% is to be invested in central government, state government securities or other approved securities. Approved investments subject to exposure / prudential norms cannot exceed 50%; and other investments subject to exposure / prudential norms cannot exceed 15%. Housing and infrastructure requires a minimum of 15% investment.

Pension and Annuity Plans: A minimum of 20% is to be invested in central government securities. A minimum of 40% is to be invested in central government securities, state government securities or other approved securities. Approved investments subject to exposure / prudential norms have a cap of 60%.

Unit Linked Insurance Plans (ULIPs): At least 75% should go to approved investments which tend to be liquid stocks with a strong dividend payment record, and not more than 25% to other investments.

General Insurance: A minimum of 20% is to be invested in central government securities. A minimum of 30% is to be invested in central government, state government securities or other approved securities. Approved investments cannot exceed 70%; and other investment cannot exceed 25%. Housing and loans to state governments for housing and fire-fighting equipment require a minimum of 5% investment and infrastructure requires a minimum of 10% investment.

Apart from these quantitative limits, investments of insurance companies are subjected to various exposure and prudential norms where there is limit for investments in investee company, entire group of investee company, and industry sector to which investee company belongs. There are also regulations which prescribe formation of investment committee, investment policy, operational control & risk management review. Regulations are also regulating investment in mutual funds, derivatives, venture capital, private equity and list of approved and unapproved investment.
1.2 Statement of the Problem

The forthcoming statement of problem is being verified by the literature review that is presented in chapter II. It is an attempt to substantiate the view that the contemporary problems do not find adequate treatment in the existing literature on the subject. The insurance industry is one of the fastest growing sectors in India. The insurance industry has registered significant growth during the last decade and emerged as an important financial intermediary. The penetration and density of the industry have also shown remarkable growth over the period of time. The growing importance of the industry may be observed in terms of growing asset under management. The premium paid by policyholders form the main source of funds for the insurance companies. The asset under management of Indian insurance industry increased from Rs. 253,769.2 crore in 2001-02 to Rs. 2,408,236 crore in 2014-15. Private insurance companies provide a wide variety of options to the policyholders since there are wide-ranging insurance schemes with investment components offered by them. There is a scant of research in India regarding the investment pattern of private insurance sector. There is a need to conduct research to know investment pattern of private insurance companies especially by analyzing investment pattern in terms of investments in government securities, housing & infrastructure investments and approved & other investments. There is also a need of research which provides an empirical analysis related to investment efficiency of insurance companies. It will help policyholders, regulators, insurance investment managers, and other participants in taking better decisions. The study will also offer suggestions to improve the investment pattern of insurance companies. Hence, the present study attempts to analyze the investment pattern of private insurance companies.

1.3 Research Gap

Review of literature which is exhibited in the chapter II sheds light on various gaps in previous researches carried out in this field. The researcher is intended to put an honest effort to provide contribution in this regard. Although investment income constitutes a large share of insurers’ income and investment activities of insurance firms have important macroeconomic consequences for the allocation of investment funds between different sectors of the economy, relatively few studies have been conducted to investigate the investing activities of insurance companies in
India. Majority of studies were based on theoretical aspect of investment pattern, investment regulation and financial performance of insurance companies. Investment pattern is not given due importance or adequately explored. The present study differs from the earlier studies on the following aspects:

- This study has made an effort to address gaps in the literature by conducting a complete and comprehensive study on investment pattern of private insurance companies which has been rarely examined in any developing country.
- Although there are many studies in the literature on the investment performance of insurance and other financial institutions in other countries, few studies on the Indian insurance industry have been found. In particular, we have not found any quantitative studies on the investment efficiency or investment performance of the insurance sector in India. This is in part due to the lack of data before or difficulty in defining an appropriate model for such a relatively immature industry.
- The present study covers a detailed theoretical and analytical research for the recent period of thirteen years ranging from 2002-03 to 2014-15 regarding investment pattern and investment efficiency of insurance companies.
- In previous studies, overall investment data have been taken to conduct research. Such overall figure may not provide meaningful inferences and the results cannot be generalized. To overcome this limitation, the present study based on 12 private life insurance companies and 8 private non-life insurance companies operating during entire study period.
- Earlier studies did not compare investment pattern across private insurance companies and did not provide insight in term of which insurance companies are more efficient than others.

1.4 Scope of the Study

In the contemporary world, insurance investment pattern have become popular due to globalization, liberalization, technological development and intensely competitive environment. The world economy is facing serious difficulties in term of failure of major financial institutions and future growth prospects have become very uncertain exposing major economies to deep recession. In the midst of all the darkness and disorder of world economy, India’s insurance sector has been amongst
the few to maintain resilience. But in India there is a need of growing balance sheet, faster credit expansion, increasing profitability and productivity similar to the insurance companies of developed countries. This study emphasizes the investment pattern as the key enabler for rapid growth of Indian insurance sector. The study of investment pattern of private insurance sector in India since 2000 would cover a span of nearly one decade (2003-2015). This span of period would be more than sufficient to find out the trends in investment pattern of insurance companies vis-a-vis investment efficiency particularly in Indian insurance sector. Keeping this in mind the present study endeavors to assess investment pattern of private insurance sector in India in terms of investments in government securities, housing & infrastructure investments and approved & other investments. Investment efficiency of private insurance sector is assessed on Constant Return to Scale (CRS), Variable Return to Scale (VRS) and Scale Efficiency (SE) measure on the basis of input (Total investment) and outputs (Investment income to policyholders and Investment income to shareholders).

1.5 Objectives of the Study

Based on the existing research gap, the goal of study is take the investment pattern debate up to a higher level of quality. Consequently, the intention of this study is to achieve the following objectives:

General Objectives:

1. To study the growth and prospects of insurance sector in post privatization period.
2. To study the nature, composition and issues relating to the investment pattern of insurance companies.

Specific Objectives:

1. To examine the investment pattern of selected private life insurance companies of India.
2. To examine the investment pattern of selected private non-life insurance companies of India.
3. To trace out the investment pattern of private life insurance sector during pre and post insurance investment regulation.
4. To trace out the investment pattern of private non-life insurance sector during pre and post insurance investment regulation.
5. To analyze the investment efficiency of selected private life insurance companies of India.
6. To analyze the investment efficiency of selected private non-life insurance companies of India.

1.6 Hypotheses of the Study

The hypotheses have been developed on the basis of theories and prior empirical evidences. In the present study following hypotheses are selected for the empirical analysis. Rejection or acceptance of hypotheses is based on significance of results.

\( H_01: \text{There is no significant difference in investment pattern across private life insurance companies.} \)

\( H_01.1: \text{There is no significant difference in government securities investments across private life insurance companies.} \)

\( H_01.2: \text{There is no significant difference in housing & infrastructure investments across private life insurance companies.} \)

\( H_01.3: \text{There is no significant difference in approved & other investments across private life insurance companies.} \)

\( H_02: \text{There is no significant difference in investment pattern across private non-life insurance companies.} \)

\( H_02.1: \text{There is no significant difference in government securities investments across private non-life insurance companies.} \)

\( H_02.2: \text{There is no significant difference in housing & infrastructure investments across private non-life insurance companies.} \)

\( H_02.3: \text{There is no significant difference in approved & other investments across private non-life insurance companies.} \)
Ho3: There is no significant difference in investment pattern of private life insurance sector in pre and post insurance investment regulation.

Ho3.1: There is no significant difference in government securities investments of private life insurance sector in pre and post insurance investment regulation.

Ho3.2: There is no significant difference in housing & infrastructure investments of private life insurance sector in pre and post insurance investment regulation.

Ho3.3: There is no significant difference in approved & other investments of private life insurance sector in pre and post insurance investment regulation.

Ho4: There is no significant difference in investment pattern of private non-life insurance sector in pre and post insurance investment regulation.

Ho4.1: There is no significant difference in government securities investments of private non-life insurance sector in pre and post insurance investment regulation.

Ho4.2: There is no significant difference in housing & infrastructure investments of private non-life insurance sector in pre and post insurance investment regulation.

Ho4.3: There is no significant difference in approved & other investments of private non-life insurance sector in pre and post insurance investment regulation.

Ho5: Private life insurance companies are not investment efficient.

Ho5.1: Private life insurance companies are not investment efficient on constant return to scale.

Ho5.2: Private life insurance companies are not investment efficient on variable return to scale.

Ho5.3: Private life insurance companies are not investment efficient on scale efficiency measure.

Ho6: Private non-life insurance companies are not investment efficient.

Ho6.1: Private non-life insurance companies are not investment efficient on constant return to scale.

Ho6.2: Private non-life insurance companies are not investment efficient on variable return to scale.
H_6.3: Private non-life insurance companies are not investment efficient on scale efficiency measure.

1.7 Research Methodology

Research methodology is an important part of research that describes the entire methodological process of the study. Under this part, sample scheme, data sources, sampling techniques, statistical tools & techniques, and variables and proxies measures are described in view of testing formulated hypotheses. The role of methodology is to carry out research in a systematic and scientific manner. The present study makes an empirical investigation of investment pattern of private insurance sector during post privatization. Therefore, this section of the chapter outlines entire research plan, which is as follows:

1.7.1 Sample Scheme

The empirical result of the study is primarily based on financial data of insurance companies. As on 31\textsuperscript{st} March 2015, there were 23 private life insurance companies, 1 public life insurance company, 22 private non life insurance companies (including five standalone health insurance companies –Star Health & Allied Insurance Co., Apollo Munich Health Insurance Co., Max Bupa Health Insurance Co., Religare Health Insurance Co., and Cigna TTK Health Insurance Co.) 6 public non-life insurance companies (including specialised insurance companies - Export Credit Guarantee Corporation of India Limited and Agriculture Insurance Company of India Limited) and one reinsurance company. Out of these companies, 12 private life insurance companies and 8 private non-life insurance companies are selected.

The purposive sampling technique has been adopted in the study while taking scope and limitation of the study into due consideration. The study imposes certain specific restrictions in the sample selection and only those firms qualify for sampling which fulfils the following criteria:

1. Companies must exist on 31\textsuperscript{st} March 2015.
2. Companies should have been incorporated in or before the financial year 2002-03.
3. Companies should have maintained its identity and reported its audited financial statements without any gaps for financial years from 2002-03 to 2014-15.
After fulfilling the above mention criteria, twelve private life insurance companies and eight private non-life insurance companies are selected. The selected sample firms are true representative of the population. Twelve private life insurance companies represent 88.75 per cent of private life insurance market and eight private non-life insurance companies cover 77.82 per cent of private non-life insurance market.

**Table 1.1: Number of Selected Private Life Insurance Companies in India**

<table>
<thead>
<tr>
<th>Name of the Insurance Companies</th>
<th>Abbreviation</th>
<th>Date of Registration</th>
<th>Year of Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviva Life Insurance Company India Ltd.</td>
<td>Aviva Life</td>
<td>14.05.2002</td>
<td>2002-03</td>
</tr>
<tr>
<td>Bajaj Allianz Life Insurance Company Ltd.</td>
<td>Bajaj Life</td>
<td>03.08.2001</td>
<td>2001-02</td>
</tr>
<tr>
<td>Birla Sun Life Insurance Co. Ltd</td>
<td>Birla Life</td>
<td>31.01.2001</td>
<td>2000-01</td>
</tr>
<tr>
<td>Exide Life Insurance Company Ltd.</td>
<td>Exide Life</td>
<td>02.08.2001</td>
<td>2001-02</td>
</tr>
<tr>
<td>Kotak Mahindra Old Mutual Life Insurance Ltd.</td>
<td>Kotak Life</td>
<td>10.01.2001</td>
<td>2001-02</td>
</tr>
<tr>
<td>Max Life Insurance Co. Ltd</td>
<td>MAX Life</td>
<td>15.11.2000</td>
<td>2000-01</td>
</tr>
<tr>
<td>PNB Metlife India Insurance Co. Ltd.</td>
<td>MET Life</td>
<td>06.08.2001</td>
<td>2001-02</td>
</tr>
<tr>
<td>Reliance Life Insurance Company Ltd.</td>
<td>Reliance Life</td>
<td>03.01.2002</td>
<td>2001-02</td>
</tr>
<tr>
<td>SBI Life Insurance Co. Ltd</td>
<td>SBI Life</td>
<td>29.03.2001</td>
<td>2001-02</td>
</tr>
<tr>
<td>Tata AIA Life Insurance Company Ltd.</td>
<td>TATA Life</td>
<td>12.02.2001</td>
<td>2001-02</td>
</tr>
</tbody>
</table>


**Market Share of Life Insurance Companies**

Life Insurance Corporation of India (LIC) represents 73.05 per cent of market and market share of private life insurance companies is 26.95 per cent. Twelve private life insurance companies represent 23.92 per cent of market and market share of other
private life insurance companies is 3.03 per cent. Graph 1.1 representing market share of life insurance companies sector.

**Graph 1.1: Market Share of Life Insurance Companies in India**

![Market Share Graph]

Source: Prepared by researcher on the basis of data from IRDAI annual report 2014-15

**Table 1.2: Number of Selected Private Non-Life Insurance Companies in India**

<table>
<thead>
<tr>
<th>Name of the Insurance Companies</th>
<th>Abbreviation</th>
<th>Date of Registration</th>
<th>Year of Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bajaj Allianz General Insurance Co. Ltd.</td>
<td>Bajaj General</td>
<td>02.05.2001</td>
<td>2001-02</td>
</tr>
<tr>
<td>Cholamandalam MS General Insurance Co. Ltd.</td>
<td>Cholamandalam General</td>
<td>15.07.2002</td>
<td>2002-03</td>
</tr>
<tr>
<td>HDFC ERGO General Insurance Co. Ltd.</td>
<td>HDFC General</td>
<td>27.09.2000</td>
<td>2002-03</td>
</tr>
<tr>
<td>ICICI Lombard General Insurance Co. Ltd.</td>
<td>ICICI General</td>
<td>03.08.2001</td>
<td>2000-01</td>
</tr>
<tr>
<td>Company Name</td>
<td>Insurance Name</td>
<td>Date</td>
<td>Year</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-------------------</td>
<td>------------</td>
<td>-------</td>
</tr>
<tr>
<td>Tata AIG General Insurance Co. Ltd.</td>
<td>Tata General</td>
<td>22.01.2001</td>
<td>2000-01</td>
</tr>
</tbody>
</table>


**Market Share of Non-Life Insurance Companies**

Public non-life insurance companies represent 50.24 per cent of the market and specialized insurers represent 4.84 per cent of market. Market share of private non-life insurance companies is 41.44 per cent and standalone health insurers represent 3.47 per cent of market. Eight private non-life insurance companies represent 32.25 per cent of market and market share of other private non-life insurance companies is 9.19 per cent. Graph 1.2 representing market share of non-life insurance companies.

**Graph 1.2: Market Share of Non-Life Insurance Companies in India**

Source: Prepared by researcher on the basis of data from IRDAI annual report 2014-15
1.7.2 Data Sources

The study is exclusively based on secondary sources of data. The financial data of companies related to investment and other variables have been extracted from IRDAI annual reports. The additional financial information has been collected from the various published annual reports and financial statements of sample companies that have been extracted from the respective website of sample companies. Furthermore, research reports of various contributors on the subject, articles in various journals, magazines, newspapers and other published literature on subject matter have been screened to gather required information for the study. Finally collected raw data has been converted into ratios and classified according to the requirement of the study.

1.7.3 Statistical Methods

In order to analyze data collected, Analysis of Variance (ANOVA), post hoc test, paired sample t test, and Data Envelopment Analysis (DEA) have been applied. One-way ANOVA is used to evaluate mean difference in investment pattern of selected private life insurance companies. One-way ANOVA is also used to analyze mean difference in investment pattern of selected private non-life insurance companies. Post hoc test is used to spell out which specific groups of insurance companies are significantly different from each other. Paired sample t test is used to analyze investment pattern of private life and non-life insurance sector during pre and post insurance investment regulation. To calculate investment efficiency of selected private life and non-life insurance companies, the technique of DEA is used. Furthermore, we have selected one indicator of input as total investment and two indicators of output as investment income to the shareholders and investment income to the policyholders. The Indian insurance industry is still in its nascent stage, so it makes sense to use output oriented Charnes, Cooper and Rhodes (CCR) model and Banker, Charnes and Cooper (BCC) model to calculate Technical Efficiency (TE), Pure Technical Efficiency (PTE) and scale efficiency. Finally SPSS (Statistical Package for the Social Sciences) version 19 is used to generate results of paired sample t test and one-way ANOVA. DEAP (Data Envelopment Analysis Computer Program) version 2.1 software is used to generate results of DEA.
1.7.3.1 One-Way Analysis of Variance

The one-way ANOVA is a statistical technique used to figure out whether the means of three or more unrelated groups are significantly different (Chalmer, 1987). To evaluate mean difference in investment pattern of selected private life insurance companies, the study employed one-way ANOVA. One-way ANOVA is also used to analyze mean difference in investment pattern of selected private non-life insurance companies. The one-way ANOVA is simply a series of independent sample t-test conducted for an independent variable that has three or more classifications. The one-way ANOVA is also called a single factor analysis of variance because there is only one independent factor or group data is characterized by a single classification (Lee, Lee, & Lee, 2000). Specifically, it tests the null hypothesis

\[ H_0: \mu_1 = \mu_2 = \mu_3 = \cdots = \mu_k \]

against the alternative hypothesis

\[ H_1: \text{At least two population means are not equal.} \]

where \( \mu = \) group mean and \( k = \) number of groups. When the one-way ANOVA provides a significant result; we can accept the alternative hypothesis \( (H_1) \) that at least two group means are significantly different from each other.

The one-way ANOVA partitions the total variability of data or Total Sum of Squares (\( SS_T \)) into two unrelated (orthogonal) components i.e. Within-Groups Sum of Squares (\( SS_w \)) and Between-Groups Sum of Squares (\( SS_B \)). Within-groups sum of squares is the variability that exists within each group and the variability that exists between the groups is called the between-groups sum of squares (Black, 2004). Hence

\[ SS_T = SS_B + SS_w \]

\[ SST = \sum (X - \bar{X})^2 \]

\[ SS_w = \sum (X - \bar{X}_j)^2 \]

\[ SS_B = SS_T - SS_w \]

where

\( \bar{X}_j \) is the mean of group \( j \).
Finally, an F ratio is calculated as:

\[ F = \frac{MS_B}{MS_W} \]

\[ MS_B = \frac{SS_B}{df_b} \]

\[ MS_W = \frac{SS_W}{df_w} \]

Where

\( df \) is degree of freedom

Mean Square Within (\( MS_W \)) or within-groups variance is the estimate based on the within-groups variability; and the estimate based on the between-group variability is known as between-groups variance estimate or Mean Square Between (\( MS_B \)) (Caldwell, 2009).

This first component \( MS_W \) mirrors the differences among subjects presented to the same treatment. It is accepted that within-groups variation of a similar magnitude exists in each of the groups. This variation within any one group is a function of the specific subjects selected at random for the group or dispensed indiscriminately to the group. Therefore, we can associate variation within a group with random sampling fluctuation (i.e., sampling error – that is why \( MS_W \) is also termed as ERROR) (Weinberg & Abramowitz, 2008).

The second component \( MS_B \) deals with the differences among group means. Regardless of the fact that there were absolutely no treatment effects, it would be far-fetched that the sample means for the groups would be alike. A more sensible expectation is that the group means will differ, even without treatment, basically as a function of the individual difference of the subjects. Consequently, we would anticipate that the group means will differ to some degree because of the random selection process in the formation of the groups. If different treatments that have an effect on the dependent variable are practiced to the different groups; we can expect even larger differences among the group means. Accordingly, the between-groups variation reveals variation because of the treatment plus variation inferable to the random process by which subjects are chosen and assigned to groups. That is the treatment effect of the independent variable plus error (Weinberg & Abramowitz, 2008).
If calculated F ratio is higher than the tabulated value, then null hypothesis can be rejected. On the other side, if calculated F ratio is less than the tabulated value, then null hypothesis can accepted. At the point when the null hypothesis is accepted (no dissimilarity between the group means or no treatment effect), it would anticipate that F will be equivalent to 1. Note that the observed mean squares simply estimate the parameters and these estimates may be larger or smaller than the corresponding parameters. Therefore, it is likely to have an observed F ratio less than 1 despite the fact that conceptually the ratio cannot be less than 1. F increases with the impact of the independent variable. In this way, the higher the F ratio is, the more reasonable it is that the independent variable has a real effect. If the F ratio is less than 1, we don’t even need to compare it with the critical value of F. It is obvious that the treatment has no significant effect, and we can quickly finish up by holding null hypothesis. Rejection of the null hypothesis reflects that there are significant differences among the sample means, a higher difference than would be anticipated on the basis of chance alone (‘Understanding the One-Way ANOVA,” n.d.).

1.7.3.2 Post Hoc Tests

The one-way ANOVA is an omnibus test statistic and cannot spell out which specific groups were significantly different from each other. To figure out which specific groups differed from one another, the study utilized post hoc tests. Post hoc tests are practise to determine where the differences occurred between groups, but they should only be run when one-way ANOVA has demonstrated an overall significant difference in group means (Weinberg & Abramowitz, 2008). Post hoc tests (or posttest) are additional hypothesis tests which run after a one-way ANOVA to confirm precisely which mean differences are significant and which are not (Gravetter & Wallnau, 2014). More specifically, a post hoc test is a follow-up statistical test which is performed after one-way ANOVA shows a significant F Ratio, without a priori hypothesis about which group difference might be causing that effect. The post hoc test is a way of pinpointing where the significant difference lies (Steinberg, 2011; Tavakoli, 2012).

Post-hoc tests endeavor to control the experiment wise error rate (generally alpha = 0.05) in the same way that the one-way ANOVA is used rather than multiple t-tests. Post-hoc tests are termed a posteriori tests because they are performed after the event. Post hoc test compare each group in a pair wise manner (Ray, 2012). There are
numbers of post hoc tests which are rather bewildering. The Least Significant Difference (LSD) post hoc test is very liberal and the scheffe test is entirely conservative so many statisticians recommend a more middle of the road test i.e. the Tukey’s Honestly Significant Difference (HSD) test (Morgan, Leech, Gloeckner, & Barrett, 2013). If the sample sizes are equal among all groups, a technique that is less conservative than Scheffe's test is Tukey's HSD test. Often, Tukey's HSD test is suggested by statisticians because it is not as conservative as the Scheffé test (which implies that you are more likely to detect differences if they exist with Tukey's HSD test)

**Figure 1.1: A Ranking of Some of the Most Conservative and Liberal Post Hoc Test**

Source: (Privitera, 2015, p 374)

**Tukey’s Honestly Significant Difference test:** Tukey’s HSD test is more conservative than some tests and computes the least significant difference that is significant between means. Tukey’s HSD test must be used with equal n (Adams & Lawrence, 2015). Tukey’s HSD allows a researcher to make all pairwise comparison among the sample means in a study while keeping up an acceptable alpha (usually .05, but possibly .01) when the conditions have equal n’s. However if there is not an equal number of participants in each condition then other post hoc tests which can be used with equal or unequal n’s should be approached (Jackson, 2012). This test is
perhaps the most prominent post hoc test. It reduces Type I error at the expense of Power. It is appropriate to utilize this test when one desires all the possible comparisons between a large set of means (6 or more means).

Tukey’s HSD test identifies the smallest difference between any two means that is significant with alpha = 0.05 or alpha = .01. Tukey’s HSD test sometimes known as Tukey’s T method is a widely accepted test for pair wise a posterior multiple comparisons. This test was developed by John W. Tukey and presented in 1953. Under Tukey’s HSD test, all means for each condition are ranked in order of magnitude; group with lowest mean gets a ranking of 1. The pair wise variations between means starting with the largest mean compared to the smallest mean are tabulated between each group pair and divided by the standard error. This value, q, is compared to a studentized range critical value. If q is more than the critical value, then group pair is considered to be statistically different (“Statistical Analysis: 1-Way ANOVA,” n.d.).

Tukey’s HSD test looks into the number of treatment levels, the value of Mean Square Error (MSE), and sample size. Using these values and a table value, q, the HSD decide the critical difference necessary between the means of any two treatment levels for the means to be significantly difference. Once the HSD is computed, the researcher can analyze the absolute value of any or all difference between pairs of means from treatment levels to figure out whether there is a significant difference (Black, 2004). The formula to compute a Tukey’s HSD test follows:

Tukey’s HSD test

\[
\text{HSD} = q_{\alpha, C, N-C} \sqrt{\text{MSE}/n}
\]

Where:

\[
n = \text{sample size}
\]

\[
q_{\alpha, C, N-C} = \text{critical value of the studentized range distribution} \quad (\text{Black, 2004}; \quad \text{Gravetter & Wallnau, 2014})
\]

1.7.3.3 Paired Sample t Test

For the purpose of data analysis, the researcher has applied paired sample t-test with the help of SPSS. This test has applied by the researcher to analyze whether there is any significant difference in investment pattern of private life insurance sector in pre and post insurance investment regulation. This test has also applied by the researcher
to analyze whether there is any significant difference in investment pattern of private non-life insurance sector in pre and post insurance investment regulation. The paired sample t test (correlated groups t-test) is used when there is only one group of participants and data collects from them on two different occasions or under two different conditions (Tavakoli, 2012). In other words, paired sample t test is used when two samples are dependent. Two samples are called to be dependent when participants selected for sample A have a relationship to participants selected for sample B (Hahs-Vaughn & Lomax, 2012). Paired sample t test is a statistical test which is applied to find out whether there is a significant difference between the average values of the same measurement conducted under two different settings. The null to be analyzed for identifying difference between means is as follows.

The null hypothesis (H₀) is that there is no significant difference between the two population means which denotes as:

H₀: µₐ - µₖ = 0 or H₀: µₐ = µₖ

Alternate hypothesis H₁ is that there is significant difference between two population means which denotes as

H₁: µₐ - µₖ ≠ 0 or H₁: µₐ ≠ µₖ

where

µₐ is the population mean for sample A
µₖ is the population mean for sample B

The statistical test requires that the following conditions should be fulfilled:

- The dependent variable is quantitative in nature
- There are two measures on the same subject (“before” and “after’ measures are commonly used) or
- There are two separate samples but the subjects in each are individually matched so that there are similar subjects in each group (but not the same subjects in each group). One important thing to note is that matching must be pairwise (Renee & James, 2012).

The calculation of dependent sample t test statistic drives from the modification of one-sample t test. Firstly, a difference score for each pairs of scores in
two samples is calculated and those difference scores treat as one sample that will be contrasted with the mean difference score ($\mu_D$) of population. The mean difference score of the population is supposed to be zero ($\mu_D=0$) that means there is no dissimilarity between samples or no impact of independent variable. The mean difference score for the paired-samples is a means of any result of treatment. If treatment does not have impact then there will not be difference between the two groups. However, if the treatment does have impact then it will increase or decrease the scores from the control situation and in this way turn out a mean difference score greater or less than zero (Renee & James, 2012).

Therefore, paired sample t test calculates the sum of the squared difference scores ($\sum D^2$), the sum of the difference scores ($\sum D$), the mean difference score ($\bar{D}$) and the standard deviation of the difference scores ($S_D$). These difference scores turn in to one sample of raw scores that compared with population mean of no dissimilarity between subjects ($\mu_D=0$). Standard deviation of the population difference scores ($\sigma_D$) computes based on the sample difference scores (Renee & James, 2012).

Formula for the paired sample t test:

$$t_{obtained} = \frac{\bar{D} - \mu_D}{SD} = \frac{\bar{D} - \mu_D}{SD} = \frac{\bar{D} - \mu_D}{SD} \sqrt{\frac{n(n-1)}{n-1}}$$

Under the null hypothesis, $\mu_D=0$, so our formula becomes

$$t_{obtained} = \frac{\bar{D}}{SD} = \frac{\bar{D}}{SD} = \frac{\bar{D}}{SD} \sqrt{\frac{n(n-1)}{n-1}}$$

where

degree of freedom = $n-1$

$\bar{D} = \frac{\sum D_i}{n}$ is the mean

$SD^2 = \frac{\sum (D_i - \bar{D})^2}{n-1}$ is the variance and the positive square root $|SD|$ is the standard deviation of the differences $D_i (i = 1, 2, \ldots, n)$.

1.7.3.4 Data Envelopment Analysis

Over the past few decades, various DEA models have been widely used to evaluate the technical efficiency of Decision Making Units (DMUs) in different industries. The performance of DMUs is measured in DEA using the concept of
efficiency which is the proportion of total outputs to total inputs. Note that the technique of frontier analysis has been portrayed by Farrell in 1957 but a mathematical framework to handle frontier analysis was further developed by Charnes, Cooper and Rhodes in 1978 (Cooper, Seiford, & Zhu, 2011; Thanassoulis, 2001). Charnes, Cooper and Rhodes developed a model that had input orientation and presumed constant return to scale. Subsequent papers have contemplated different sets of assumptions, such as Banker, Charnes and Cooper proposed a variable return to scale model in 1984 (Coelli, Rao, & Battase, 1998). As the names indicate, these two models differ in the matter of their assumptions on returns to scale. Constant return to scale assumes that each additional unit of input produces the same proportion of output. The assumption on variable return to scale in model allows the output generated by a unit of additional input to vary according to scale size.

DEA uses linear programming techniques to form a non-parametric frontier over the data for assessing the relative performance of a set of firms that use a variety of identical inputs to provide variety of identical outputs (Ramanathan, 2003). DEA estimates “best practice” efficient frontiers comprising of the best performing firms in an industry. Performance of other DMUs in the industry is measured relative to the frontiers. Efficiency scores range from 0 to 1 where efficient DMUs have efficiencies equal to 1 and inefficient DMUs have efficiencies less than 1 (Cummins & Xie, 2008).

Investment efficiency of insurance industry depends on the overall condition of domestic economy, capital market conditions, investment portfolio of insurance companies and expertise of asset managers. Therefore, investment portfolios of insurance companies become a grueling task to this industry. In this context, constant monitoring of investment efficiency of individual insurance companies and setting benchmark for relatively inefficient ones become pivotal for growth and sustenance of this industry. It is in this backdrop that this study makes a modest attempt to examine relative investment efficiency of individual insurance companies and set the best-practice benchmark for the under-performed firms. For this purpose, technical efficiencies and scale efficiencies of insurance companies have been measured through DEA. In contrast with conventional performance index measures, DEA technique embraced all the relevant factors (classified as inputs and outputs) into a single model. In addition, DEA quantifies the relative efficiency regarding the best
observed performance, as opposed to other techniques based on the observed average values or some predetermined performance. Efficiency analysis is based on the data collected from 12 private life insurance companies and 8 private non-life insurance companies for the financial years 2002-03 to 2014-15.

Some works have been done on insurance industry performance measurements. The most commonly acknowledged method utilized by insurance companies to benchmark their performance has been the ratio analysis (Yang, 2006). The most widely recognized ratios used to assess investment performance are the ratio of net investment to total income and the ratio of net investment income to net premiums. Both of the ratios are generally used by industry analysts, since investments generate a significant proportion of income for the insurance industry. Traditionally used ratio analysis gives moderately insignificant amounts of information while taking into account the effects of economies of scale, the identification of benchmarking policies and the estimation of overall performance measures of firms. As a result, there is an impetus to use more viable methods in assessing the investment performance of insurers. In the investment approach, insurers are considered as financial intermediaries whose functions are to issue fortuitous claims to policyholders and use the proceeds to purchase a portfolio of assets (Wu, Yang, Vela, & Liang, 2007). The objective of this approach is to measure the ability of an insurer to augment profits. Therefore, one input and two outputs are chosen for the investment model. Fig. 1.2 provides the conceptual model for analysis of investment efficiency.

**Figure 1.2: Model for Analysis of Investment Efficiency**
Output orientation (the Linear Programming is oriented to maximum possible increase in outputs) is opted for the investment model, since the investment managers want to maximize the investment gains. Efficiency of any firm can be characterized in terms of either input minimization or output maximization. In first case, DEA model strives for the maximum possible decrease in input usage with output level held constant. However, for the output oriented case, DEA method seeks the maximum increase in output production, with input level held fixed. Therefore, an output-efficient decision making unit is one that cannot increase its output unless it increases one or more of its input and an input-efficient decision making unit is one that cannot decrease its input unless it decreases one or more of its output. One point that should be stressed is that both output and input oriented models will estimate exactly the same frontier and therefore identify the same set of DMUs as being efficient. It is only the efficiency measures associated with the inefficient DMUs that may vary between two models.

The study utilized both BCC and CCR envelopment surfaces to examine scale efficiency issues as given in equation 1 and equation 2. In other words, efficiency is measured here under two different assumptions, viz. variable return to scale and constant return to scale. Variable return to scale permits Increasing Return to Scale (IRS) and Decreasing Return to Scale (DRS). Here, the sum of weights of linear program is restricted to 1. This gives the measure of pure technical efficiency. Constant return to scale model assumes a non negative constraints instead of the VRS constraints on weights. This gives the measure of technical efficiency (Yang, 2006).

The mathematical solution to implement the conceptual model is given in equation 1 and equation 2. Assume there are data on K inputs and M outputs on each of N firms or DMUs. For the i-th decision making unit these are represented by vectors of $x_i$ and $y_i$ respectively. The $K*N$ input matrix, $X$, and the $M*N$ output matrix, $Y$, represent data of all N DMUs. $\lambda$ is a vector of constant.

Equation 1 represents output oriented CCR DEA model and Equation 2 represents output oriented BCC DEA model.

\[
\begin{align*}
\text{Max}_{\Phi, \lambda} & \Phi, \\
\lambda Y & \geq \Phi y_i \quad \text{(equation 1)} \\
\lambda X & \leq x_i \\
\lambda & \geq 0
\end{align*}
\]
Performing a DEA analysis requires the solution of N linear programming problems of the above form, one for each decision making unit. In the study, there are data on twelve life insurance companies for 13 years; hence there are twelve linear programming problems for CCR DEA to be solved in a particular year. While eight non-life insurance companies are taken into consideration for 13 years, hence there are eight linear programming problems for CCR DEA to be solved in a particular year. The CRS linear programming can be easily modified to account for VRS by adding the convexity constraint: $N'\lambda = 1$ to equation 1 to provide:

$$\begin{align*}
\text{Max}_{\Phi, \lambda} & \Phi, \\
\lambda Y & \geq \Phi y_i \quad \text{(equation 2)} \\
\lambda X & \leq x_i \\
N'\lambda & = 1 \\
\lambda & \geq 0
\end{align*}$$

$N$ is $N\times1$ vector of ones. The approach forms a convex hull of intersecting plans which envelope the data point more tightly than CRS hull and thus provide technical efficiency score which is greater than or equal to those obtained using the CRS model.

Note that the linear programming problem given in equation 2 must be solved N times, once for each decision making unit in the sample for a particular year. In the study, there are data on twelve life insurance companies for 13 years; hence there are twelve linear programming problems for VRS DEA to be solved in a particular year. While eight non-life insurance companies are taken into consideration for 13 years, hence there are eight linear programming problems for VRS DEA to be solved in a particular year.

In order to investigate the sources of inefficiencies in DMUs, technical efficiency can be bifurcated into two components i.e. pure technical efficiency and scale efficiency, where $TE = PTE \times SE$, by solving addition linear programming problems. This decomposition manifests the causes of inefficiency i.e. whether it is due to inefficient operation (PTE) or by disadvantageous conditions displayed by the scale efficiency or by both (Aparicioa, Mahlberg, Pastora, & Sahood, 2014). This may be done by applying both constant return to scale and variable return to scale DEA models upon the same data.
The CCR score is termed as technical efficiency or global technical efficiency. The BCC score is called pure technical efficiency or local pure technical efficiency. If a decision making unit is found to be efficient in both the CCR and BCC models, it is operating at the most productive scale size. If a decision making unit has full PTE score but a low Overall Technical Efficiency (OTE) score, then it is operating locally efficiently but not globally efficiently due to the scale size of the decision making unit (Ramanathan, 2003). Thus, it is sensible to represent the scale efficiency of a decision making unit by the ratio of the two scores.

Let the CCR and BCC scores of a decision making unit be $\theta^*_\text{CCR}$ and $\theta^*_\text{BCC}$ respectively. The scale efficiency is defined by

$$\text{SE} = \frac{\theta^*_\text{CCR}}{\theta^*_\text{BCC}}$$

TE refers to the firm’s ability to deliver the maximum possible output from a given combination of inputs and technology. TE also refers to the gross efficiency and overall technical efficiency. In DEA, it is determined by the difference between the observed quantities of a firm’s output(s) to input(s) and the ratio achieved by best practice firms that are taken as benchmark to measure its efficiency. It is therefore a relative technical efficiency not the absolute one. Its value lies between zero and one. PTE alludes to the proportion of TE which is attributed to the efficient conversion of inputs into output(s). It captures the pure resource-conversion efficiency. Value of PTE score also lies between zero and one, and is greater than or equal to TE score. PTE is measured relative to a VRS frontier, which may have segments whether best practice firms operate with increasing return to scale, constant return to scale, and/or decreasing return to scale. SE is determined by dividing the TE score from the PTE score for a firm (Cummins, Tennyson, & Weiss, 1999).

Furthermore, it is important to point out that peer count of a firm represents the extent of its robustness compared with other efficient firms. The higher number of peer count of a firm represents that it is more robust than other efficient firms. Specifically, a firm with higher peer count is probably efficient one with respect to large number of factors and likely to be a good example of a “global leader”. Efficient firms that appear occasionally in the reference set are likely to have a very uncommon input/output combination and therefore cannot be treated as a good example to be followed by the inefficient firms (Agarwal, Yadav, & Singh, 2014).
For this study, DEA is adopted for the following reasons:

(1) It particularly useful in dealing with insurance industry which is a service industry and there is limited knowledge of underlying production technology,

(2) It avoids the choice of a specific functional form and requires no distributional assumptions. Such assumptions can create specification errors, with unknown effects on the efficiency estimates,

(3) Indian insurance industry is relatively small and DEA can ideally be able to handle relatively small size,

(4) It allows for convenient decomposition of technical efficiency into pure technical efficiency and scale efficiency,

(5) This approach focuses primarily on the technological aspect of production functions. It can be used to estimate productive efficiency without requiring estimates of input and output price,

(6) DEA has good statistical properties. Banker (1993) shows that DEA is equal to maximum likelihood estimation. DEA estimators are consistent and converge faster than estimators from other frontier methods (Casu, Girardone, & Molyneux, 2004; Cummins & Zi, 1998).

Past Literature on Efficiency in the Insurance Industry (Basis for Selecting Input & Output Variables)

<table>
<thead>
<tr>
<th>Authors</th>
<th>Countries</th>
<th>No. of insurers</th>
<th>Sample period</th>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahmad (2010)</td>
<td>India</td>
<td>10</td>
<td>2001-2009</td>
<td>Share capital including the reserves and surpluses</td>
<td>Shareholders’ investment</td>
</tr>
<tr>
<td>Barros and Obijiaku (2007)</td>
<td>Nigeria</td>
<td>10</td>
<td>2001-2005</td>
<td>Capital, operative costs, number of employees, total investments</td>
<td>Profits, net premiums, settled claims, outstanding claims, investment income</td>
</tr>
<tr>
<td>Bawa and Kaur (2013)</td>
<td>India</td>
<td>10</td>
<td>2003-2010</td>
<td>Investment</td>
<td>Investment income to the policyholders, Investment income to the shareholders</td>
</tr>
<tr>
<td>Bawa and Kaur (2011)</td>
<td>India</td>
<td>10</td>
<td>2003-2010</td>
<td>Investment income, net income</td>
<td>Claim incurred</td>
</tr>
<tr>
<td>Researcher(s)</td>
<td>Country</td>
<td>Sample Size</td>
<td>Time Period</td>
<td>Key Variables</td>
<td>Notes</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------</td>
<td>-------------</td>
<td>-------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Diacon, Starkey, and O’Brien (2002)</td>
<td>15 European countries</td>
<td>454</td>
<td>1996-1999</td>
<td>Total operating expenses, total capital, total technical reserves, total borrowings from creditors</td>
<td>Net earned premiums (general, long-term), total investment Income</td>
</tr>
<tr>
<td>Mahlberg and Url (2003)</td>
<td>Austria</td>
<td>70</td>
<td>1992-1999</td>
<td>Expenditures on labor, material, energy, depreciation, marketing, commissions (1 input); capital mgt. cost (1 input)</td>
<td>Claims, net change in provisions, allocated investment returns, bonuses and returned premia</td>
</tr>
<tr>
<td>Author(s)</td>
<td>Country</td>
<td>Period</td>
<td>Inputs/Outputs</td>
<td>DEA Activities</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>---------</td>
<td>-----------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Lazaridis, and Lyroudi (2001)</td>
<td></td>
<td></td>
<td>input) and payment to insurers and expenses incurred in the production of services (1 input)</td>
<td>investment activities</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Inv: Net actuarial reserves, investment expenses, total investments, total segregated funds</td>
<td>Inv: Investment gains in bonds and mortgages, investment gains in equities and real estate</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Inv: Net actuarial reserves, investment expenses, total investments, total segregated funds</td>
<td>Inv: Investment gains in bonds and mortgages, investment gains in equities and real estate</td>
<td></td>
</tr>
<tr>
<td>Yao, Han, and Feng (2007)</td>
<td>China</td>
<td>1999-2004</td>
<td>Labor, capital, payment and benefits</td>
<td>Premiums, investment income</td>
<td></td>
</tr>
</tbody>
</table>

**Selection of Inputs and Outputs**

Identification of input-output variables for the estimation of technical efficiency is the first and the most important stage in the DEA. The efficiency scores depend on the choice made regarding inputs and outputs. Potential input-output variables can be pinpointed through past literature or statistical analyses such as correlation and regression. The study identifies input and output variables through the past literature as shown above. It is generally advocated in the literature that input-
output variables in the DEA model should be as few as possible in order to retain discriminatory power on the comparative efficiencies of the units being evaluated (Thanassoulis, 2001). The choice of input-output variables is essential issue in DEA because distribution of the efficiency scores is influenced by it (Sarkis, 2007). In this study, total investment is taken as input and investment income to the shareholders and investment income to the policyholders are taken as outputs.

**Selection of Number of DMUs**

Typically, the selection of input and output variables, and the number of DMUs determine whether a good discrimination exists between efficient and inefficient units. There are two clashing contemplations when evaluating the size of the data set. One consideration suggests including as many DMUs as possible because with a larger population there is a greater likelihood of catching high performance units that would shape the efficient frontier and enhance discriminatory power. On the other side, homogeneity of the data set may decrease with a large data set and some exogenous factors of no interest to the analyst or beyond control of the manager may affect the results. A homogeneous group of units is one where: (a) all units perform the same task with similar targets; (b) all the units perform under the same set of market conditions; (c) input and output factors utilized to measure the performance of all units in the group are alike except for difference in intensity or magnitude (Golany & Roll, 1989).

Yet, there are some rules of thumb on the number of inputs and outputs to choose and their relation to the number of DMUs. Boussofiane, Dyson, and Thanassoullis (1991) prescribed that the lower bound on the number of DMUs should be the multiple of the number of inputs and the number of outputs in order to get good discriminatory power out of the CCR and BCC models. This reasoning is obtained from the issue that there is flexibility in the selection of weights to assign to input and output values in determining the efficiency of each decision making unit. In an attempt to be efficient, a decision making unit can dole out all of its weight to a single input or output. The decision making unit that has one specific proportion of an output to an input as highest will assign all its weight to those particular inputs and outputs to seem efficient. The number of such possible inputs is the product of the number of inputs and the number of outputs. For instance, if there are 4 outputs and 3 inputs the minimum total number of DMUs should be 12 for some discriminatory power to exist.
in the model. Golany and Roll (1989) gave a rule of thumb that the number of units should be at least twice the number of inputs and outputs considered. For instance with a 4 outputs and 3 inputs model Golany and Roll prescribed using 14 DMUs. Dyson et al. (2001) suggested a total of two times the product of the number of input and output factors. For instance with a 4 outputs and 3 inputs model Dyson et al. prescribe 24 DMUs.

In any condition, these numbers should likely to be used as minimums for the basic efficiency measurement models. These criterions endeavour to ensure that the basic efficiency measurement models are more discriminatory. If it is realized that the discriminatory power is diluted because of the few DMUs, the number of input or output factors can be reduced (Sarkis, 2007). The present study utilizes one input and two outputs which meet all the above mentioned criteria. Hence, good discriminatory power is expected to exist in the model.

**Negative Numbers and Zero Values**

Many times the data set will have negative numbers. Basic DEA models can’t complete an analysis with negative values and all values must be non-negative and ideally rigorously positive (no zero values). This has been characterized as the “positivity” requirement of data envelopment analysis. One of the more commonly used technique for removing the complexity of non-positive numbers in DEA has been through the addition of an optimally large positive constant to the values of the inputs or outputs that has the non-positive number (Sarkis, 2007). In the study, investment income to policyholders reported negative results for most of private life insurance firms in the year 2007-08, 2008-09 and 2011-12. DEA cannot be deal with negative values; therefore an arbitrary constant value is added to the investment income of respective years.

**1.7.4 Variables and Proxies Measures**

The selection of variables and their measurements are primarily based on the prior theoretical and empirical findings and the availability of data.

Government securities investments, housing & infrastructure investments, and approved & other investments are taken to analyze investment pattern of insurance companies.
Government Securities Investments

Government securities are tradable instruments issued by central government or state government which have sovereign rating and fetch very high safety label (Baradhwaj, 2013). Government securities are the safest securities as there are no considerable changes in their values, but the return on these securities may not be higher. Large amount of funds of the Indian insurance companies are invested in government-related securities. Regulations prescribed that a minimum of 50 per cent of life fund; 40 per cent of pension, annuity and group fund; and 30 per cent of general insurance invested assets are to be invested in central government, state government or other approved securities. Investment of substantial amount of fund in government securities can deteriorate ability of fund to earn adequate return on their investments due the low yields from the government securities. However, a significant increase in these securities investments is useful to insulate the insurance sector from interest rate risks. Many of insurance companies have been expressing their persistent confidence in government securities. Majority of funds invested in government securities are more than regulatory requirements. The largest class of assets in any insurers’ portfolio by virtue of regulatory and liquidity requirements are government securities. Central government securities, state government securities or other approved securities mainly include central government bonds, special deposits, deposit under section 7 of Insurance Act, 1938, central government guaranteed loans / bonds, state government bonds, state government guaranteed loans and guaranteed equity.

Housing and Infrastructure Investments

Infrastructure development is very crucial to the development of an economy. It is now mandatory for the insurance companies to divert their funds to housing and infrastructure sector. At present, it is mandatory for life insurance companies to invest up to 15 per cent of their invested assets of traditional plans in infrastructure and housing securities. General insurance companies are required to invest 5 per cent of their invested asset in housing and 10 per cent of their invested asset in infrastructure securities. The insurance funds are an important source of funding for infrastructure projects. As, many of these projects are undertaken by private sector due to the reform process, insurers may put their sum in these private sector infrastructure projects. However, IRDAI prescribed that at least 75 per cent of the infrastructure investment
should be placed in AAA-rated bonds. This requirement can restrict flexibility of insurance companies in selecting the bonds and companies in which they could invest. Present norms allow investments by way of subscription or purchase of bonds / debentures issued by Housing and Urban Development Corporation Limited or National Housing Bank or Housing Finance Companies either properly certified by National Housing Banks or backed by Government or carrying current rating of not less than ‘AA’ to be referred as housing investments. Asset Backed Securities (ABS) with underlying housing loans would also qualify for housing investments. Investments in infrastructure are made by subscription or purchase of bonds/debentures, equity and asset backed securities with underlying infrastructure assets.

**Approved and Other investments**

Section 27A for life insurance companies and Section 27B for general insurance companies give detailed criteria for treating an investment as approved investment. Restrictions are put on the amount to be invested in approved investments and other investments as per a detailed list that includes specific equities, corporate bonds and bank deposits. Approved investments are in companies that have a strong, multi-year dividend payment record. The regulatory authority has also through the investment regulations imposed that debt instruments up to AA credit rating assigned by the rating agencies are treated as approved instruments. Investments that do not fit these criteria are called other investments.

**Table 1.3: Proxy Measures for Variables of Investment Pattern**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Proxy measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government securities investments</td>
<td>Central government securities, state government securities or other approved securities investments/ Total investment</td>
</tr>
<tr>
<td>Housing &amp; infrastructure investments</td>
<td>Housing &amp; infrastructure investments/ Total investment</td>
</tr>
<tr>
<td>Approved &amp; other investments</td>
<td>Approved &amp; other investments/ Total investment</td>
</tr>
</tbody>
</table>

To analyze investment efficiency total investment is taken as input and investment income to shareholders & investment income to policyholders are taken as output variables. The output and input variables are defined as:
Output Variables

Investment returns are divided between two parties i.e. those who have purchased the policies and those who have contributed in the capital of the company. The investment income earned on investments held on behalf of shareholders has been taken to the Profit & Loss Account and those held on behalf of policyholders has been taken to the Revenue Account. Therefore, the output indicators are as follows:

Investment income to the policyholders: The net returns on investments to the policyholders or income from investment in revenue account have been taken as first output.

Investment income to the shareholders: The net returns on investments to the shareholders or income from investment in profit/loss account have been taken as the second output.

Input Variable

Total investment: Total investment under management has taken as the indicator of input. In other words, here input = central government, state government or other approved securities investments + housing & infrastructure investments + approved & other investments

<table>
<thead>
<tr>
<th>Variables</th>
<th>Proxy measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input variable</td>
<td>Total investment</td>
</tr>
<tr>
<td>Output variables</td>
<td>Investment income to shareholders</td>
</tr>
<tr>
<td></td>
<td>Investment income to policyholders</td>
</tr>
</tbody>
</table>

1.8 Limitations of Research

1. First and foremost, only private life and non life insurance companies have been included in final sample. Yet public sector represents a large market share and contributes a lot to industry.

2. Indian insurance companies include 23 private life insurance companies and 17 private non life insurance companies (excluding standalone health insurance companies) out of which 12 from private life and 8 from private non life insurance company taken as sample.
3. The reference period has been taken from the post liberalization period that range from 2000-2015, but due to unavailability of data before 2002-03 the researcher has taken data from 2003 to 2015.

1.9 Structure of the Research

In order to achieve objectives of the present study, the entire work has been broadly divided into following six chapters.

The present chapter “Introduction and Research Design of the Study” provides introductory background on investment pattern of insurance sector and explains the importance of study on the subject matter. The chapter defines the statement of problem, research gap, research objectives, hypotheses, and explain the scope, expected contribution and limitations of the study. It also deals with entire methodological process of the study. Under this part, sample scheme, data sources, sampling techniques, statistical tools & techniques, and variables and proxies measures are also discussed.

Chapter II “Review of Literature” is devoted to review the existing theoretical and empirical literature on present status, challenges and future prospect of insurance industry, investment pattern of insurance companies, investment regulation of insurance companies and investment performance of insurance companies.

Chapter III “Privatization of Insurance Sector in India” deals with the concept of privatization, rationale of privatization both positive and negative, shortcoming of privatization, privatization in India, economic and financial sector reform and privatization of Indian insurance sector in detail which covers formation of the committee for reform in the insurance sector, establishment of IRDAI, entrance of private companies and growth and development of Indian insurance sector during post privatization.

Chapter IV “Investment Pattern of Insurance Sector in India” provides concept of investment in insurance companies, the approach of investment, principles of insurance investment and determinants of investment pattern of insurance sector in detail. This chapter also presents growth and trends of investment of insurance sector.

Chapter V “Investment Pattern of Private Insurance Sector in India since 2000: Analysis and Interpretation” analyzes the investment pattern of private insurance
companies and evaluates investment pattern of private insurance sector in pre and post insurance investment regulation. Furthermore, the study analyzes investment efficiency of private insurance companies. The finding of this chapter provides better understanding of investment pattern of private insurance companies.

**Chapter VI “Findings, Conclusion and Suggestions”** concludes the research finding and offers suggestions. Finally, it provides direction for future research on the subject matters.

**1.10 Contribution of the Study**

Research studies these days are gaining an unprecedented focus and attention. A researchable area in any academic discipline is an area that has an ample scope to be explored. Investment pattern of insurance companies has become an interested area in both academic and practitioner community because of changing insurance investment regulations and growing importance of insurance companies as institutional investor. The present study is an empirical work based on secondary source of information. The study not only fulfils the requirement of the academic degree but also it is part of social commitment to bring out the facts and realities of investment pattern and its importance to insurance sector since liberalization. The study will not only help its readers but also help the future researcher as their guide. The study further makes an attempt to point out that investment pattern will play a very crucial role in getting the Indian insurance sector aligned with global standard. This study would of value to different stakeholders. The study would be valuable to future researchers and academicians in the area of finance and especially portfolio management. The findings of this study would act as a source of reference for future scholars besides suggesting areas for further research where they can extent more knowledge. It would also be valuable to policy makers to observe investment behaviour and portfolio management in the insurance industry in India. It may help key regulators in the insurance industry including the IRDAI to develop rules and regulations governing the investment behaviour of the insurance industry. The findings would also be valuable to investment managers in the insurance industry to have more information on different ways of forming a portfolio and how it can affect investment efficiency.
1.11 Conclusion

The chapter covers statement of problem, research gap, scope of the study, objectives and hypotheses. The study of investment pattern and investment efficiency of private insurance sector in India covers a span of nearly one decade (2003-2015). This span of period would be more than sufficient to find out the trends in investment pattern of insurance companies vis-a-vis investment efficiency particularly in Indian insurance sector. It also elucidates research methodology used in the study that provides an adequate and resonant foundation to research in terms of sample scheme, sources of data and various statistical tools and techniques. The pertinent use of statistical techniques can provide very constructive insight into the issue. It essentially helps the investigator in designing strategies for gathering the required evidences, analyzing it and reporting the findings. Finally, the chapter culminates with explaining the limitations, expected contribution and chapter scheme of the study.