**Addis Ababa University**
**School of Graduate Studies**

# EFFICIENCY AND PRODUCTIVITY OF ETHIOPIAN INSURANCE INDUSTRY

By:

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**A Thesis Submitted to the School of Graduate Studies Addis Ababa University In Partial Fulfillments of the Requirements for the Degree of Master of Science in Economics (Economic Policy Analysis)**



**July, 2006**

**Addis Ababa**

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# ACKNOWLEDGEMENTS

First and foremost, I would like to thanks almighty Allah for every thing He has done in my life and for the strength He gave me to complete my study.

My deep gratitude goes to my advisor Dr. Shail Singh for her valueable advice and guidance. .I also wish my to express my profound thanks to my friend Abdu kedir for his every sort of help through out our study.

.The study would have not been easy to be accomplished with out generous and unlimited assistance of The United Insurance Co. (S.C.) I would like to thank all the close friends Abdulhakim Abubeker and Bedri Abdurahman who stood by me who are helped me in editing my paper and gave me continues moral support and encouragement. I thank my friend Berhanu keber and Beharu Zein for their encouragement and assistance.

My word of special thanks also goes to my sister Fethia Abdurahman for making my study in my home easy and comfortable. Her love and cooperation served as an inspiration to the completion of this work

Last but not least my special thanks go to my parents for their trust to invest in me in the first place and their continued encouragement and belief in the dreams I pursued. They have always been a pillar of strength and a source of good advice.

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## Abstract

*This paper attempted to analyze efficiency and productivity growth of Ethiopian insurance industry in the period 1996-2005. Towards this aim, a three-stage analysis is carried out. Firstly, a Data Envelopment Analysis (DEA) approach is used to estimate technical efficiency scores. Secondly, DEA-based Malmquist indices are calculated to analyze productivity of the industry. Thirdly, a Tobit regression analysis is carried out to identify the reasons for the differences existing among the insurers in terms of technical efficiency. The inputs used are labor, business service and material, dept capital and financial capital. The outputs used are earned premium and investment income. The results indicate that the overall technical efficiency of the general insurance market was found on average 80.50 and 93.20 percent under assumption of constant return to scale and variable return to scale. The average scale efficiency for the sample period was 85.50 percent. The result of Malmquist productivity analysis revealed that the industry analysis showed that the industry the industry experienced productivity deterioration over the sample period, with an average decline of about 5 percent. The productivity decreased due to technological regress. Finally, a* second-stage *analysis highlights that technical efficiency appeared to be closely related to the company size, loss ratio and solvency ratio, partly explain inter-company differences in efficiency. To improve efficiency and productivity of the industry human resource development, revising minimum capital requirement and prudential regulation of supervisory authority could be important.*

# CHAPTER ONE

# INTROUCTION

## 1. 1. Background

The measurement of efficiency and productivity is basically of great value for every organization employing inputs to produce outputs or services. These measurements can serve as inputs for policy formulation and contribute to resource allocation process. Besides, from a managerial perspective they are powerful tools that provide a platform for assessing performance of an organization and identifying best practices. That is true for financial institutions such as insurance sector.

The insurance sector is one of the prominent components of the financial sector, along with banking and securities sectors. It play significant role in a growing economy in terms of providing indemnification to risk faced by both individual and institution. Moreover, it has a number of roles to play such as contributing towards employment generation, strengthening linkage with other sectors of the economy, in promoting growth and stability, and creating sizeable impacts on the national income of the country.

In developed countries the insurance industry does not only serves as the above mentioned roles but also it is part of their daily life. However, in developing countries like in Ethiopia, insurance is still depends up on individual's disposable income, religious belief and government policies and other factors. Nonetheless, the growing role of the insurance in an economy can not be ignored in many developing economies as the sector plays essential roles in economic growth and development of the country. However, the insurance industry plays its economic roles only when it is efficient. In the case of Ethiopia, no attempt was made to evaluate the efficiency of the insurance industry. Thus, it is very important to undertake empirical assessment on the performance of the insurance sector particularly on the technical efficiency and productivity of the sector with a view of increasing its contribution to the national economy.

## 1. 2. Statement of the Problem

Economists have long recognized that financial sector in general and insurance market in particular, plays a vital role in the efficient functioning of a growing economy. Insurance sector represents one of the tools which are of prime importance in an economy. In short insurance has dual roles: as an infrastructural and commercial service. As an infrastructural service, insurance plays a key role in economic development. A well–functioning insurance sector enables efficient allocation of a country's capital and channels national savings to investments. As a commercial services its importance stems from its ability in offering securities for the economic agents by covering economic and financial risks. Given these dual roles, the sector directly and indirectly affects the activities of individuals, business firms and the economy as whole.

Like in many other developing countries, Ethiopian insurance industry is in an infant stage of development. However, there are some positive developments in the industry following the transformation of the country's economic policy from centrally planned to market oriented economy ,and the industry is also sufficiently advanced to permit at least to evaluation of its efficiency performance and productivity growth. To liberalize the insurance sector, a proclamation no. 84/94(inFebruary, 1994) which dealt with licensing and supervision of insurance business was promulgated. This proclamation allowed the involvement and active participation of domestic private sector in the insurance market with principal objective of improving the efficiency of insurance market and enhances consumers' choices, which in turn facilitate better performance of the economy.

Accordingly, eight private insurance companies were emerged and are operating in the industry.

For insurance sector, efficiency would imply improved profitability, better utilization of resources, greater soundness that has sufficient capacity to fulfill its promises, increasing chance of success in a competitive market, and better service quality for consumers. This is particularly relevant in Ethiopian insurance industry where there is fierce competition among insurers for market share. Thus, emerging of efficient and productive local insurers is not the only principal source for the growth of Ethiopian insurance industry, but also benefits the whole economy through better protection of existing and future economic resources, availability of more investment, and economic growth in the economy.

Despite the importance of the insurance sector in the economy, very little is known about its efficiency and productivity of Ethiopian insurance industry since the liberalization of the market. Moreover, no empirical study that has investigated the efficiency and productivity performance of the industry seem to exist. This paper, therefore, attempted to make empirical evaluation on the technical efficiency and productivity growth of the Ethiopian insurance industry with particular focus on general insurance[1], which constitutes the major transaction undertaken by all insurers in the industry ,over ten years period from 1996 to 2005, thereby fill the existing gap in the area. The key operating characteristics of insurers will be introduced to make empirical test whether these affect the estimated degree of efficiency during the sample period.



## 1. 3. Objectives of the Study.

The general objective of this study is to estimate the, technical efficiency and productivity growth and examines the factor that plays important role in determining the technical efficiency of Ethiopian insurance industry. The specific objectives of the study are:

- To measure the level of technical efficiency of the Ethiopian insurance industry.
- To measure the industry's productivity growth for the last ten years.
- To apply regression analysis so as to identify factors or firms' characteristics that influences the estimated technical efficiency scores.

- To estimate the level of impacts of individual components (such as change in pure technical efficiency and technical change) that have on productivity.

- To suggest policy recommendation for the efficiency improvement and productivity growth of the Ethiopian insurance industry.

## 1. 4. Significance of the Study

The measurements of efficiency and productivity of the financial sector are important for the purpose of policy formulation. Regulators are also interested in efficiency of performance of the industry with the aim of protecting interest of the public. So the finding under this study is important in providing supportive insight about efficiency and productivity features of the Ethiopian insurance industry, which could be beneficial to the supervisory authority for prudential regulation and policy formulation. The study also equally yields insurers useful comparative and benchmarking information to evaluate and recognize the industry position and can motivated them to adopt the best practice.

Lastly, the study will contribute in filling the literature gap in the area and can motivate other researchers for further study.

## 1. 5. Scope and Limitation of the Study

The scope of this study was limited to non–life insurance which is highly benefited by the consumer of insurance. The analysis of this study included those insurance companies that have been providing general insurance service during the period of 1995 through 2005, i.e. companies that have been in continuous existence from the period 1996 through 2005 including public owned insurers, Ethiopian Insurance Corporation. These include National Insurance Company of Ethiopia, Africa Insurance, The United Insurance, Nyala Insurance, Awash Insurance, and Nile Insurance. Theses companies are representative of the industry as they hold more than 89 percent of the market share in terms of premium production for the sample period. To accomplish this study the researcher has faced data problems particularly availability of few materials on insurance subject and non–existence of previous studies on the area which can be used for review literature are the main limitation of the study.

## 1.4. Organization of the Study

The study has four five chapters. The first chapter is an introduction part, which included statement of the problem, objective of the study, significance of the stud, and scope and limitation of the study. Chapter two embodies review of related literature. Chapter three consists of methodology of the study and sources of data. Empirical results of the study are presented and discussed in the fourth chapter. The regression analyses in identifying factors that affect the efficiency of the Ethiopian industry are also analyzed in this section. The final chapter offers concluding remarks and policy implication of the study.

# CHAPTER TWO

# LITERATURE REVIEW

## 2. 1. Insurance and its Economic Roles

Many researchers tended to indicate that a well developed financial sector and its various components including insurance have substantial potentials for spreading positive externality through the commercial sector of the economy. A large and growing theoretical literature exploring the nature of the relationship between economic growth and insurance have developed and suggested that a well functioning and efficient insurance industry is fundamental to economic growth. The more efficient and developed country's insurance market the greater its contribution to economic growth. There are several ways in which insurance services contribute to economic development. The followings highlight the broader economic contributions of insurance industry in the economy.

- ***Promoting financial stability:*** Risk is unavoidable feature of any economic phenomenon. Insurance play crucial role in promoting financial stability through indemnification of risk at individual, society, corporate and national level thereby encouraging individuals and firms to specialize, create wealth, and undertake beneficial projects they would not otherwise consider. With out insurance, individual and firms could incur significant loses and not engaged in activities to create wealth. Insurance allow risks to be transferred to an entity that is better able to deal with it and let the economic agents to specialize and undertake more risky projects. [Das, Davies and Podpiera, 2003]. In doing so, it permits economic activities to operate with less volatile and risk of failure, thus providing financial stability with in national economy. .

- ***Facilitate trade and other economic activities at both domestic and international level:*** Given the heavy reliance of all economic activities (e.g. manufacturing, shipping, aviation, medical, and banking services) on risk transfer, insurance services play a key supporting role. Thus, several products and services are made and transacted when adequate insurance is available. More broadly, insurance can give investors financial confidence to make investments, since they know they will be able to recover their investment in the case of high risky new business venture, and the provision of financing is often contingent up on asset being adequately insured. With out wide insurance product choice, insurance inadequacies can hamper both trade and investments. Insurance also supports the economics activities by enhancing the credit worthiness of the economic agents. As the result, banks and other credit institutions typically insist that loan collateral to be insured or they will not extend the loan. In these ways efficient insurance services therefore can truly serve as lubricant of trade and facilitator of investment.

- ***Encourage loss mitigation: Insurance has a positive externality to reduce risk in the economy:*** As noted above, insurance cover individual and organization against losses. The detailed statistical and other knowledge about loss causing events and activities of insurers give insurers comparative advantage over many other firms engaged in loss control. So, on their activities, insurers evaluate potential losses in such away that the greater potential loss the higher cost of insurance. Importantly, as the price of the insurance rises, individual face increased incentive to control losses that will assist in the efficient allocation of resources. In addition insurers support many loss control programs, typically of which are fire prevention, industrial loss prevention and other loss control mechanism. These program and activities reduce both direct and indirect losses in the economy. Any reduction in loses can benefit the economy at large.

- ***Facilitate innovation in the economy:*** risk accompanies most economic activities. New endeavors which are particular driver of economic growth are typically accompanied by even more risk. Thus, insurance provides the answer to such risk in new growth area in the economy. Many authors identify this as central contribution. Insurance provides the vital market function of allocating pricing of risks. The efficient pricing of risk and its transfer to those best equipped to handle it contribute significantly to resource allocation and economic growth [Eostello, 2004].

- ***Foster more efficient allocation of capital allocation through its prudent investment activities***: Insurers spend time on collecting information to evaluate project's firms and individual in their decision to issue and price insurance and in their investment activities. These enable them to distinguish between productive and inefficient project comparison, individual saver, and investor typically do not have time, resource or ability to collect this information. Moreover, activities of insurer in continually evaluating and monitoring risks, provides market with information on likelihood of losses which can lead to improved resource allocation[Webb,2000]. Therefore, in collecting and managing pool of insurance premiums, insurers are part of the group of institutional investor which have become key holders of finical asset and have increasingly important role in to day's capital market [OECD, 2003]. A well functioning and efficient insurance sector with range of products and services can lead economic growth by facilitating the allocation of capital.

- ***Mobilize savings and enhance financial intermediation:*** It is suggested by many economists that the rapid economic growth could stem from either increased saving rate or introduction of new technology or method that increase productivity. The collection of premium by insurers also provide a mechanism by which saving are mobilized in to domestic investment. By collecting Premium funds from large number of policy holders, insurers are able to provide finance required for lending required for large projects such as road projects and railway. These assist the national economy in expanding the set of feasible investment projects and encourage economic efficiency and productivity.

Therefore, based on the means by which insurance underpin economic growth, the conclusion is that a well functioning and efficient insurance industry have potentially constructive roles to play in financial sector of the developing countries.

In view of the importance of insurance in empirical research literature, one might have expected several researchers on the relation between insurance and economic growth. Unlike the situation with banks which enjoy by comparison a substantial body of supportive research, in-depth research in insurance is sparse and largely anecdotal. Patric(1966) suggested that insurance and economic growth either have supply-leading or demand–following relationship with economic growth. In supply –leading view, economic growth can be induced through the supply of financial service while demand-following view, the demand for financial service including insurance can induce growth of financial institutions.

Though the precise linkage between insurance and economic development poorly understood, some empirical researches to date have suggested that on average, an overwhelming positive relationship between insurance sector development and economic growth is evident that a well developed and efficient insurance market contribute to economic growth. Ward and Zurbrug [2000] employed Granger-Casualty test by data of nine OECD countries during 1961 -1996 period and they found that insurance sector cause economic growth in some countries while in others countries have showed difference in casual relation ship between insurance market development and economic growth. Thus, to what extent does insurance contribute to economic growth and to what extent does economic growth stimulate the development of insurance sector is unclear. Also, Outrevile [1996] investigated the economic significance of insurance in developing countries. He compared 48 developing countries and concluded that a well developed and efficient insurance market contributes to economic growth.

To conclude, a substantial and growing body of evidence suggests that robust and efficient insurance markets improve an economy's ability to organize and allocate its resources efficiently.

## 2.2. A Brief Overview of Efficiency Concept and Measurement

Efficiency and productivity are two core concepts in economics. They are important performance indicators by which production units can be evaluated. Efficiency concept is used to characterize the utilization of resources. Efficiency is statement about the performance of processing a set of inputs in to a set of outputs.

Traditionally, to estimate efficiency, researchers used certain simple ratios such as labor productivity (output per unit labor employed) or capital intensification (capital per labor). Similarly, the efficiency of insurance firms had been measured by conventional financial ratios such as expense and claim ratio, return on invested assets and solvency margin. However; there are a number of problems associated with such simple ratio-based analysis. First, it is generally impossible to identify best practice organization because it is unlikely that all ratios will point to the same firm or firms. Second, if the ratios disagree, it may difficult to decide in advance which ratio should be given most weight in order to compare organizations .Third, the traditional approach do not readily allow firms to identify the source of inefficiency. The modern approach to efficiency measurement tries to circumvent the problems associated with the traditional method by using frontier efficiency method. The modern approach of measuring economic efficiency was began with Farrell (1957) who introduce the concept of efficiency frontier approach that measure firms performance relative to the best practice frontier consisting of other firms in the industry. A frontier function represent the best practice technology, against which the efficiency of the firms with in the industry can be measured (Coelli, 1996). If the firm belongs to the frontier, it is efficient, otherwise inefficient.

Frontier efficiency method is superior to the conventional ratio approach of measuring efficiency for the following reasons. First, the frontier efficiency is important to test economic hypothesis. Second, it provides guidance to regulators and policy makers regarding the appropriate response to the problems and development of the industry. For instance frontier methodology can be use to determine whether consolidation is likely to bring service improvement provided to consumers. Third, the application of frontier is useful to compare the economic performance across countries. A fourth application is to inform the management about the evaluation of firm's productivity and efficiency over time and performance departure

Farrell et.al, (1957) introduced efficiency measure that consists of two components: technical (or physical) efficiency and allocative (or price) efficiency. The product of two measure of efficiency give a measure of total economic efficiency, which also referred to as economic efficiency or cost efficiency .Technical efficiency reflects the ability of a firm to produce maximum potential output from a given amount of resource inputs or to use a minimal amount of inputs to produce a given amount of output under certain technology, and it signifies how far the firm can increase output without utilizing additional resources. Thus, technical efficiency depicts the ability of a firm to produce on the production frontier. Allocative efficiency refers to extent to which a firm uses input in optimal proportion for a given set of inputs price and technology .In other words allocative efficiency represents the ability of choosing optimal input level for a given factor price. Technical efficiency can be further decompounds in to pure technical efficiency (PTE) and scale efficiency (SE). Scale efficiency is used to determine how close an observed firm is to the most productive scale size [Banker and Thrall, 1992] .A firm is scale inefficient if it exceeds the most productive scale size (therefore experiencing decreasing return–to scale) or if it is smaller than the most productive scale size (there fore failing to take full advantage of increasing return to scale). Scale inefficiency for a firm is defined with respect to those firms in the industry which operate where average and marginal products are equal [Forsand, 1980]

Many authors have pointed out the relevance of measuring technical efficiency. Farrell et.al, (1957) argues that measuring technical efficiency is important because it allows us to determine whether outputs can be increased simply by raising efficiency, without needing to increase input quantities. Moreover, Lovell (1993) states that measuring efficiency makes it possible to rank and evaluate the decision making units (DMUs) analyzed, thus permitting the design of incentive mechanisms to reward the best DMUs, as well as policies to raise efficiency. The concepts of Farrell's technical efficiency and allocative efficiency are best illustrated by using simple example involving firm which utilize two inputs($x_1$, $x_2$) to produce a single output (y) under assumption of constant return to scale. In figure 1 bellow **QQ'** is isoquant for a firm, which represents the various combination of the two input($x_1$, x2) required to produce a desired fixed amount of output by using the state of production technology. Firms which are operating on the isoquant are therefore considered as technically efficient.

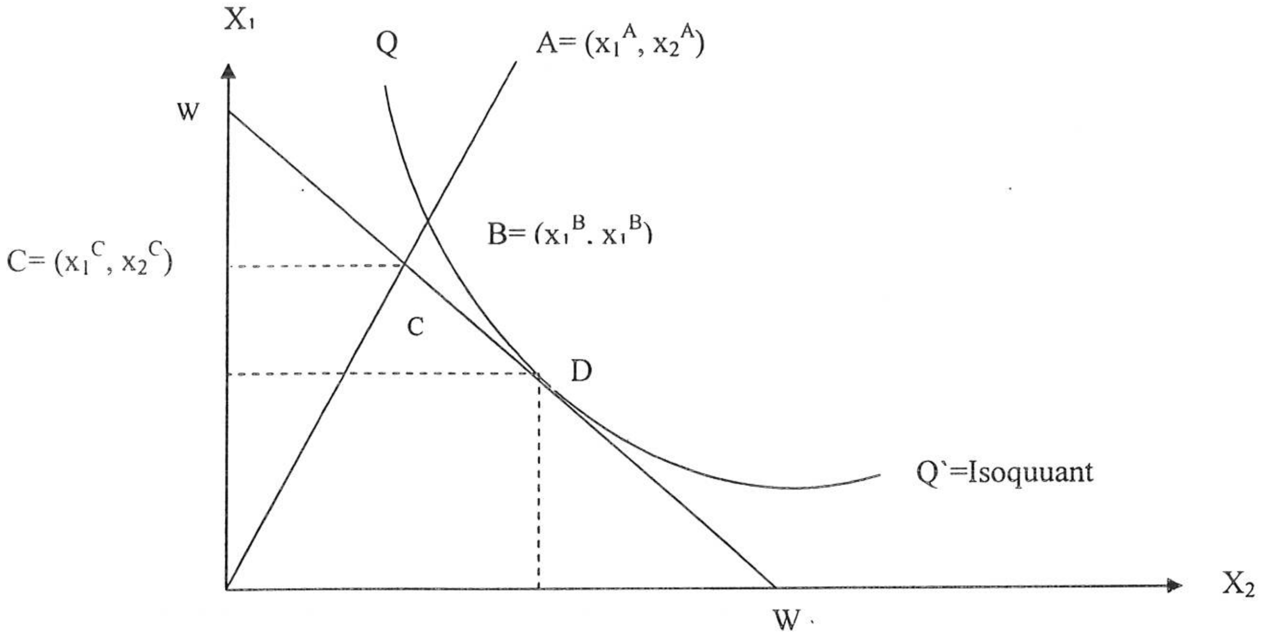


Figure 1: concept of technical efficiency and alloccative efficiency

The distance ***AB*** represents the technical inefficiency of a firm. That is the amount by which all inputs could be proportionally reduced with out any reduction in output. This is usually expressed in the percentage term by the ratio **AB/OA,** which represent the percentage by which all inputs need to be reduced to achieve technically efficient production. The technical efficiency of the firm at point B is most commonly measured by the ratio **OB/OA**. It takes the value of between 0 and 1, that value of one indicates the firm is fully efficient. In figure **1** above, point B is technically efficient since it lie on the efficient isoquant **QQ'**. The technical efficiency ratio of the firm at **B** is **OB/OB** or unity. In addition, it is important to measure the extent of firm uses the various factor of production in best proportionalities, considering prices. In fig. **1**, the input price ratio is presented by the slope of isocost line WW' and allocative efficiency can be calculated. Allocative efficiency of a firm operating at point **A**=($x_1^A$,$y_2^A$) is defined to be the ratio of **OC/OB** because the distance **AB** represent the reduction in production cost that would occur if production where to occur at the allocative and technically efficient point **D** instead of technically efficient but allocatively inefficient point **B**

Frontier efficiency has been used extensively in measuring the level of efficiency. Frontier efficiency estimation techniques can be classified in to parametric (econometric) and non–parametric (mathematical programming) approaches. The econometrics approaches rely on a parametric or functional specification of input-output relation such as production, or profit function characterizing the data. It normally recognizes that deviation from the given technology is measured by error terms which consist of two parts; one represents randomness, and the other inefficiency. The usual assumptions with the two components are that the inefficiency follow the asymmetric half normal distribution and random error term is assumed normally distributed .The random error is generally thought to encompasses all events outside the control of the firm including both uncontrolled factors directly related to the actual production function and econometric error, such as misspecification of the functional form and error term. In contrast to econometric approach, the mathematical programming method uses the linear programming technique to evaluate the efficiency of the organization relative to the other organization in the industry. This approach don't normally have any stochastic components .Hence, it assume that any departure from frontier are the result of inefficiency .The most commonly used version of mathematical programming methods is **Data Envelopment Analysis (DEA).** DEA approach for measuring efficiency was introduced by Charnes, Cooper and Rhode Charnes (1997). DEA is non-parametric in the sense that it simply constructs the frontier of the observed input-output ratios by linear programming techniques. It compares decision-making units (DMUs) that use the same inputs to generate outputs to get the relative efficiency measures of individual DMUs

Both the parametric and non parametric approaches have their own advantages and limitations. The primary advantage of the econometric parametric is that it allow the firms to deviate from the efficiency frontier due to purely random error as well as through inefficiency .But the primary challenge in implementing the parametric approaches is determining how best to separate random error from inefficiency because both are not observable. The econometric approach however, has been criticized for potential confounding estimate of efficiency with specification error as it requires the specification of functional form of which characterize input –output relation .Hence, any resultant efficiency scores will potentially depend on how accurately the chosen functional form represent the production relation. On the other hand unlike parametric approach, non-parametric method has advantage of not having to specify the form of production or error term. However, one potential problem with non-parametric approach is that it does not have any stochastic error components. So that, any deviation from frontier is assumed to be inefficient.

In general both mathematical programming and econometric approach are widely used for the analysis of efficiency. The success of both methods relies on some common factors such as include that all inputs and outputs are homogeneous input and output across firms and their measurability accurately. In the empirical literatures it is quite common to use DEA.

## 2.3. Review of Empirical Studies on Insurance Efficiency

With the rapid evolution of frontier efficiency methodologies, interest on analysis of efficiency and productivity of insurance industry has been grown, but mostly focused on developed countries (USA, Italy, France, Australia, Germany, etc.). Much of the empirical studies tended to concentrate on life-insurance [example include Fukuyama (1997), and

Hardwick (1997)]. Among the better-known studies on the efficiency and productivity of insurance sector, Cummin and Weis recorded 20 studies across countries and the vast majority of their studies are US based with out any report concerning developing countries (Charnes, Cooper and Rhodes, 1997). A number of these studies have employed DEA and DEA-based Malmquist indices to analyze efficiency and productivity, respectively.

Worthingston and Hurley (2003) analyzed the efficiency of Australian general insurance for the year 1998 by adopting DEA. This study used intermediation approach to select insurance output, and included labor, physical capital and financial capital as inputs. The outputs are net revenue premium and investment income. The finding of their study showed that the average efficiency score of Australian general insurance industry was 0.58. The main source of inefficiency appeared to be technical inefficiency

With reference to the impact of market liberalization on life insurance in four Asian countries Thivade, Martin and Harold (2001) employed data of the 1980-1997 periods to investigate the impact of market liberalization on life insurance efficiency and productivity using DEA and Malmquest index across four Asian countries, namely Taiwan, Korea, Philippine and Thailand. The paper used three inputs: labor, financial capital and business services. The outputs were gross premium and investment income. The empirical findings of the research revealed that the liberalization of the Korean and Taiwan insurance were associated with improvement in efficiency and productivity whereas for Philippine and Thailand the liberalization seemingly failed to stimulate efficiency and productivity.

As mentioned above, the empirical literatures addressing the efficiency of insurance sector in developing economies has been rather limited. Indeed, one of the available literatures on such works was from Thivade, Martin and Harold (2000) which evaluated the technical efficiency of the Tunisian insurance industry using panel data for the period 1990 through 2000.Their findings showed that the variability of technical efficiency scores across companies over the period studied. Besides, they indicated the efficiency estimates obtained by both parametric and non-parametric (DEA) approaches had much consistency for the same data set.

More recently, Tayler, Yijia and Hoa (2004) assessed efficiency and productivity growth of Chinese insurance sector over 1995-2002 periods. They employed two outputs and three inputs using value added approach, the inputs were labor (number of full time employees) debt capital and financial capital. Whilst outputs were loss incurred and invested asset. Their empirical results showed that the average technical efficiency of over the sample period was 0.976 with no significant difference between foreign and domestic insurers with respect to technical efficiency and productivity growth

Almost all empirical literatures which estimate insurance efficiency were attempted to make regression on a set of environmental or explanatory variables such as asset size, geographic concentration, organizational form, and other financial information so as to explain variations in efficiency. However, there is a considerable lack of information on what are the main determinants of efficiency with in insurance sector. This is an important area which deserves further investigation.

To sump up, the literatures reviewed indicate that there is no clear consensus on the specification of insurance output in spite of large number of studies on efficiency and productivity of insurance sector. Some earlier literatures used losses as amount of out put measure. Most recent emerging literatures used premium as proxy for the output measure. Another group of authors used physical output measure as number of policies. The latter measure was employed by Kellner and Mathewson (1993), Weiss (1993), and Bernlisten (1997). It would be useful for future research to compare the efficiency scores using alternatives definition of outputs. On the other hand, there is more uniformity in the choice of inputs. Nearly all studies used labor, capital and business service to cover inputs. On the subject of comparison of different efficiency methodologies, the two studies that make such comparison [Ferrier and Lovell: 1996 and Humphery: 1997] found that the same efficiency ranking except small difference in terms of estimated efficiency scores. The efficiency scores of DEA is generally expected to be lower than econometric scores because it measure all departure from frontier as inefficiency, where as the econometric approach allows for random error. To provide new information on the effect of choice of methodology in efficiency estimation, more studies are needed to be done.

## 2.4. An Overview of Ethiopian Insurance Industry.

The introduction of insurance in its modern form in Ethiopia is closely associated with the establishment of Bank of Abyssinia, the first bank in Ethiopia by the year 1905. In that period the bank of Abyssinia was transacting marine and fire insurance by being the agent of foreign insurance company. The Baloise set up a branch office in Addis Ababa and was soon followed by other foreign companies working on agency basis. Until 1950, there was no any locally incorporated insurance company. In 1952, the first national insurance company, Imperial Insurance Company was started operation. During the period insurance business like any commercial activities was administered by the provision of the commercial code. With the promulgation of proclamation

No 281/1997 *Insurance council and insurance Controller's* office was set up so as to control and regulate insurance business in the country. At the end of 1975, there were 13 private insurance companies operating in the country. The Derg, socialist government in 1975 nationalized all insurance companies, and by proclamation No. 68/1975 established Ethiopian Insurance Corporation [EIC] which took all their assets and liabilities. Consequently, from the period 1976 to 1994, the insurance market was dominated by one a state owned insurance company, Ethiopian Insurance Corporation, which enjoyed a complete monopoly of all insurance business in the country. .

A new paradigm of financial sector policy came in to being in 1994 when proclamation of *Supervision of Private Banks and Insurance* was enacted. This legislation allowed private insurance companied to be formed and compete with EIC. The current legal basis for insurance industry in Ethiopia is Licensing and Supervision of Insurance Business Proclamation No 86/1994. The Ethiopian Insurance Industry is currently composed of eight private insurance companies along side one public owned insurer. Five of the companies including the public owned corporation engaged in composite insurance[2] and the rest four companies are specialized transacting general insurance [non-life].

[2] **Composite insurance is defined as being all class of insurance i.e. both life and general insurance**

However, the law does not allow the participation of foreign insurance companies .The main justification behind the prohibition of foreigners was that the management capacity of the regulatory body is weak and the local industry is undeveloped and needed time to building up its capital reserves and its strength. In this situation rapid opening would expose local insurers to domination by financially stronger foreign insurers. The supervisory and regulatory functions over insurance companies have also been delegated to National Bank of Ethiopia. The objective of the bank in this regard is to establish and maintaining regulatory/supervisory framework which effectively and efficiently promote the development of the insurance in the country.

Under the 86/1994 proclamation, the minimum capital requirement for a non life company is Eth Birr three Million while for a life company is four Million and Eth Birr 7 Million for a composite. Currently no general insurance company in the market has a capital of less than Eth Birr 8 Million and no composite insurer has a capital less than Eth Birr 25 Million.

There is no local reinsurance company operating in Ethiopian in spite of the fact that Ethiopian Insurance Corporation accepts inward reinsurance, which accounts for insignificant of the premium, and most reinsurance placed externally.

Like in most developing countries, the Ethiopian insurance industry is limited. As can be seen in table 1 the life insurance shares less than 6 percent out of the total insurance business in Ethiopia which indicates that the life insurance is very much in its infancy stage relative to the general insurance, which also can be explained by low levels of income and lack of public awareness about the benefits of insurance.

In order to make out the current picture and potential development of insurance industry, it is important to examine both insurance penetration and insurance density rates. Both measures employ local country factors to chart the relative progress of insurance. Insurance density measures premium volume in relation to a country's own population, i.e. how much money per-capita is spent annually on insurance related products. Insurance penetration defined as the ratio of premium to GDP and measures the significance of the insurance industry in comparison to the country's economic activity. As such, it measures the significance of the insurance industry in comparison to a country's total domestic economic activity. Despite increasing trend in the premium production over the years as indicated in table–1, both the insurance density and penetrations have remained stable at a relatively low level during the decade, and lag behind many other developing countries. The average insurance penetration for Ethiopia during the last decade was less than 1%; where as for other developing economies is between 1.2 and 2.00 percent [Bodla, Gorg and Singh, 2003)

*Table 1*: The market concentration and penetration of Ethiopian insurance industry.

*In million*

| Year / Description | G.C / E.C | 1996 (1988) | 1997 (1989) | 1998 (1990) | 1999 (1991) | 2000 (1992) | 2001 (1993) | 2002 1994 | 2003 1995 | 2004 1996 | 2005 1997 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gross Premium | Non-Life | 301.00 (97.26%) | 333.57 (96.7 %) | 365.50 (96.74%) | 387.05 (96.74%) | 424.05 (96.74%) | 455.10 (95.95%) | 554.33 (95.96%) | 555.57 (95.96%) | 568.23 (95.10%) | 640.23 (94.36%) |
| | Life* | 8.45(2.74) | 11.33(3.29) | 13.05(3.26) | 15.26(4.89) | 19.38(4.89) | 19.38(4.02) | 23.23(4.02) | 25.68(4.41) | 27.85(4.80) | 36.09(5.64) |
| GDP at Market Price | — | 48,803.30 | 55,373.11 | 53,156.59 | 57,256.01 | 63,924.39 | 65,688.74 | 62,665.20 | 68,144.09 | 83,891.62 | 96,676.35 |
| Insurance Penetration | — | 0.63% | 0.62% | 0.71% | 0.70% | 0.69% | 0.72% | 0.92% | 0.85% | 0.71% | 0.70% |
| Insurance concentration | — | 6.211 | 6.923 | 6.979 | 7.176 | 7.262 | 7.367 | 8.710 | 8.528 | 8.525 | 9.338 |

Source: compiled from the data obtained from MOFED and NBE

* Figures in brackets are percentage

The average insurance concentration for Ethiopia is Birr8.50 (nearly USD 0.95) which compared with USD 6.5 for neighbor Kenya and average of USD8.2 for the whole Africa. These parameters signify to the fact that the spread of insurance business has relatively been poor in Ethiopia and large section of the population is still isolated from insurance coverage. Some of the reasons for low development of in insurance are the low level of income of the population, limited awareness from the part of the insurable. The future potential growth of the market size is however is vast as given low insurance penetration and density.

Generally, the Ethiopian insurance industry is characterized by very low insurance penetration and concentration, low level of awareness about benefit of insurance by general public, relatively small number of products in the market, concentration of the market in major urban areas, and unhealthy competition. The competition for market share is focused on mainly on premium cutting to the level labeled as uneconomic. Many insurers have expressed their concerns on that unwanted trend of uneconomic rates cutting, which still exists, have an adverse impacts on the profitability and healthy performance of the industry by eroding the financial strength of the industry. Due to strong drive for market share, many insurers particularly the private players seem to use excessive credit facility as marketing tools to attract customers. Trade debtor is the other major threat of the Ethiopian insurance industry. In seeking a solution to the chronic problem of uncollected premiums, some companies in the industry has continued to request stronger supervisory attention to establish "no premium no cover" provision in the form directive. To minimize this problem, the supervisory authority, however, issued a directive in March, 2004, which demand insures to maintain specific minimum provision for out standing trade debtor balances over and above four months.

# CHAPTER THREE

# METHEDOLOGY AND DATA

## 3.1. Methodology of the Study

The empirical study in this paper adopted three stages of analysis. The first step involves measurement of technical efficiency using non–parametric technical technique, Data Envelopment Analysis (DEA). In this step the study also conducted separate efficiency estimation by including and excluding Ethiopian Insurance Corporation (the dominant insurer) in order to test for possible biases in the results due to significant size difference between EIC and private insurance companies. In the second step the productivity growth of the insurance industry is examined using Malmquest Productivity Index (MPI). All DEA-based efficiency and productivity estimations for the sample data were carried out using DEAP version 2.1.In the third procedure an attempt was made to identify the major determinants of technical efficiency of Ethiopian insurance industry using regression analysis. The choices of DEA and Malqmuist Productivity Index methodologies in this study were for the following reasons.

i) Both DEA and MPI don't require explicit specification of the production relation and assumption about functional form of technology. Thus, they minimize specification errors and the efficiency estimates are not conditional on the accuracy of the chosen functional forms' approximation.

ii). The approach techniques allow for multiple inputs and multiple outputs without the use of weighting factors

iii) DEA provides a particular convenient method for decomposing technical efficiency in to its components, pure and scale efficiencies. Besides, Malmquist Productivity index can be decomposed in to measure of technical efficiency change and technical change.

iv) A Malmquist approach, which is the most standard methodology used for measuring productivity progress or regress over time is DEA based .Thus employing DEA allow the application of the same methodology both for the analysis of productivity and efficiency.

v). Both DEA and Malmquist approaches are able to handle relatively small data group which is ideal for analyzing the case of Ethiopian insurance industry.

### 3.1.1. Specification **of DEA** Model and Measurement of Technical Efficiency

Technical efficiency was estimated by employing DEA, non-parametric mathematical programming approach for frontier efficiency analysis. The increasing popularity of this approach is endorsed by the fact that between 1992 and 2001 over 400 articles, books and research papers involving DEA approach were published (charnels, 2002). Further, DEA was wisely used to measure efficiency of financial sector and extensively outlined in insurance studies [Burger and Humphrey, 1997].

*DEA* analyzes firm's efficiency relative to all the observations in the sample i.e. a firm's performance is measured against that of the best performer(s) in an industry. In the context of DEA the individual units analyzed are also referred to as decision-making units. A decision-making unit is a firm that responsible for converting inputs into outputs whose performance is to be evaluated. DEA is non-parametric approach that empirically implements Shepherd's distance function (1970).It has guided much of the development in efficiency and productivity analysis. For example: – Fare (1984, 1994) has shown how shepherd's distance function is closely related to efficiency indexes. The distance function is functional representation of multiple input and output technology that require data only on unique quantities of those input and output. It measures the distance between the given input or out put vector and the benchmark vector as the inverse of the vector by which the vector has to be scale up or down to be on the benchmark[Grsskop,1993] .Thus, the distance function allows modeling the production frontier as well as deviation from it.

The technical efficiency can be identified either by using input or output oriented specification. The application of DEA in this study adopted the input-oriented efficiency measure.The input-based efficiency measure the extent to which the input vector will be proportionally contracted output vector under specified technology. The main reason for the choice of input-oriented efficiency measure is that insurance companies have more control over their inputs than their out puts i.e. input quantities are the primary decision variable. In this case, the objective is to produce the desired output with minimum amount of inputs .Therefore, input vector is rescaled in constructing efficiency frontier:

Consider a production process involving $\mathbf{X}=(x_1,x_2,x_3,\text{------}x_k)\ \varepsilon\ \mathbf{R}_n^{+}$ input vector to produce $\mathbf{Y}=(y_1,y_2,y_3,\ldots,\ y_n)$ output vector, where $\mathbf{Y}\ \varepsilon\ \mathbf{R}_n^{+}$ and k and n are number of inputs and outputs, respectively. The underlying production technology is represented by $\mathbf{V(y)} \subseteq \mathbf{R}_k^{+}$ for any $\mathbf{Y}\ \varepsilon\ \mathbf{R}_n^{+}$, $\mathbf{V(y)}$ denote the subset of all input vector $\mathbf{X}\ \varepsilon\ \mathbf{R}_k^{+}$ which yield at least **Y**. Following Shephard (1970), Fare (1988) and Fare et al. (1994), input-oriented distance function is given by

$$\mathbf{D(x,\ y)} \quad = \mathbf{sup}\left[\theta : \left(\frac{x}{\theta}, y\right) \varepsilon (y)\right] \qquad \textbf{(1)}$$

$$= \mathbf{inf}\left[\theta : (\theta x, y) \varepsilon V(y)\right]^{-1}$$

Where, $\theta$ measures the level of efficiency. Equation no. 1 reflects firm's ability in minimizing its input utilized to produce a given level of output. The input–based distance function is the same as the reciprocal of the minimum equi–proportional contraction of the input vector **X**, given out put vector **Y** i.e. Farrell's technical efficiency. Thus, technical efficiency, TE (X, Y) is defined as

$$\mathbf{TE} = \frac{1}{D(X,Y)} \text{..........................} \qquad \textbf{(2)}$$

The quantity D(X, Y) is always greater than one (>1) and, $0<\text{TE} \leq 1$.

For each year, technical efficiency is estimated separately for each firm in the sample by solving linear programming problems. There are several different ways to present DEA model of technical efficiency using linear programming problems. The simplest representation for firm **i** is the following:

$$[\ D(x_i, y_i)\ ]^{-1} = \mathbf{TE\ (x,\ y)} = \mathbf{min}\,\theta \qquad (3)$$

Subject to: $Y\lambda_i \geq \mathbf{Y_i}$

$X\lambda_i \leq \theta_{iXi}$ and

$X\lambda_i \geq 0$

Where **X=K x I** input vector and Y is **N x I** output vector for all sample firms, $\mathbf{x_i}$ is **K x 1** input vector and $\mathbf{Y_i}$ is **N x 1** out put vector of firm **i**, $\lambda$ is **I x 1** is intensity vector which indicate at what intensity each activity can be employed in production, and i and stands for the number of firms or decision making units(DMU) in the sample (i.e. =1,2,3,------,I). The constraint $\lambda i \geq 0_i$ imposes constant returns to scale (**CRS**). DMU's with elements of $\lambda i$ that are non–zero, is the set of "best practice" reference DMU's for the firm under analysis.

In the DEA problem the performance of a producer is evaluated in terms of his ability to contract its inputs vector subject to the constraints imposed by best observed practice. If radial contraction is possible for a producer optimal $\theta\ \pi\ 1$, while if radial contraction is not possible its optimal is $\theta = 1$

Technical efficiency measurements by the *DEA* model can be used to determine both pure technical efficiency (**PTE**) and scale efficiencies (**SE**), where **TE=PTE*SE**, by solving additional linear programming problems. Pure technical efficiency is measured relative to a variable returns to scale frontier, which may have segments where best practice firms operate with increasing returns to scale, constant returns to scale, or decreasing returns to scale. Scale efficiency on the other hand is primarily concerned with whether a *DMU* is operating at its optimal capacity/ size in comparison to other *DMUs* in its industry. Scale efficiency can be determined in a technology with variable returns to scale (*VRS*). *VRS* is when a proportional increase in inputs does not lead to the same proportional increase in outputs.

To obtain a variable returns to scale frontier we estimate equation **(3)** with the additional convexity constraint $\sum_{i=1}^{I} \lambda_i = 1$. Pure technical efficiency is the reciprocal of the distance of firm **i** from the variable returns to scale frontier. Therefore, a firm can increase its pure technical efficiency by moving toward the variable returns to scale frontier.

If the firm is operating in the increasing returns to scale or decreasing returns to scale region of the variable returns to scale frontier, it could further improve its technical efficiency by operating with constant returns to scale. Firms with **PTE=TE** are operating with constant retns to scale and thereby are scale efficient, SE = 1. To distinguish between firms operating in the decreasing returns to scale (**DRS**) region and the increasing returns to scale (**IRS**) region an additional linear programming problem is solved. The convexity constraint in the variable returns to scale problem $(\sum_{i=1}^{I}\lambda_i = 1)$ is replaced by an alternative constraint $\sum_{i=1}^{I}\lambda_i \leq 1$, that modifies the problem to account for non–increasing returns to scale (**NIRS**). If **TE** does not equal **PTE** and **PTE** equals the **NIRS** efficiency measure then the firm is with operating with **DRS**. However, if TE does not equal **PTE** and **PTE** does not equal the **NIRS** efficiency measure then the firm is operating with **IRS** (Aly, 1990).

To sum up DEA can estimate efficiency under the assumption of constant returns to scale (CRS) and variable returns to scale (VRS). The CRS assumption is only appropriate when all DMUs (insurers) are operating at optimal scale. However, factors like imperfect competition and other factors may cause insurers not to operate at optimal scale. As a result, the established insurance efficiency literature that uses linear programming techniques to estimate efficiency tends to use the VRS approach as suggested by Banker et al (1984).

### 3.1.2. The Measurement Productivity Growth (Malmquist Analysis)

Malmquist Productivity index (MPI) is a valuable method for measuring productivity because it can be decomposed in to measure of technical change and efficiency change. It measures productivity change by comparing the position of a firm in two adjacent time periods with respect to a best practice frontier, measured by using the idea of the distance function.

The study adopted an input–oriented Malmquist Index .Definition of MPI require obtaining distance function with respect to different time Periods. So, let modify the equation {1} to incorporate time and define distance function with respect to two different time period.

$$D_t(X_{t+1}, Y_{t+1}) = \sup\left[\theta : \left(\frac{X_{t+1}}{\theta}, Y_{t+1}\right) \varepsilon V_t(Y_{t+1})\right] \text{.................}(4)$$

$$D_{t+1}(X_t, Y_t) = \sup\left[\theta : \left(\frac{X_t}{\theta}, Y_t\right) \varepsilon V_{t+1}(Y_t)\right] \text{...................}(5)$$

$D^t$ and $D_{t+1}$ denote the input oriented distance function with respect to production technology at time **t** and **t+1**, respectively. $X_t$ and $X_{t+1}$ are input vectors at time **t** and **t+1**, respectively. $Y_t$ and $Y^t{}_{+1}$ are the corresponding output vectors. In equation (4) the input–output relation in time period **t** is evaluate relative to the technology of time period ***t+1*** and in equation [5] the input–output bundle observed in period **t+1** is evaluated relative to the production technology time ***t*** i.e. function in equation [4] measure the maximum proportional change in output relative to the technology existing at the previous period ***t***. Similarly, the equation [5] measure the maximum proportional change in output given the set of input relative to technology at time period **t+1**

In such analysis, the objective is determining whether productivity change has occurred between period **t** and ***t+1***.Two main changes might occur between these two periods .First, because of technical progress, the firm produce more output per unit input in period ***t+1*** than in period ***t***. Thus, technical change has taken place. Second the firm experience technical efficiency gain by operating closer to the frontier in time ***t+1*** than the period ***t***. The Malmquist approach measures these two changes.

The Malmquist Productivity Index can be defined relative to either reference to the technology period for ***t*** or the technology in period ***t+1*** i.e

$$\mathbf{M}_t = \frac{D_t(X_t, Y_t)}{D(X_{t+1}, Y_{t+1})}$$

$$\mathbf{M}_{t+1} = \frac{D_{t+1}(X_t, Y_t)}{D_{t+1}(X_{t+1}, Y_{t+1})} \quad \ldots\ldots\ldots\ldots\ldots\ldots(6)$$

Where: $M_t$ measures productivity growth between period **t** and $t_{+1}$ using technology of period **t**.

$M_{t+1}$ measures productivity growth using technology in period **t+1** as reference technology

To avoid arbitrary choice of reference technology, the input oriented MPI is defined as the geometric mean of Mt and Mt+1 (see Fare,et al., 1994)

$$M\,(X_{t+1}, Y_{t+1}, X_t, Y_t) = \left[ \left( \frac{D_{t+1}(X_t, Y_t)}{D_t(X_{t+1}, Y_{t+1})} \right) \left( \frac{D_{t+1}(X_t, Y_t)}{D(X_{t+1}, Y_{t+1})} \right) \right]^{1/2} \ldots (7)$$

The Malmquist index represent are the productivity of production any point from $(X^t, Y^t)$ relative the production point $(X_{t+1}, Y_{t+1})$. Each measure take any positive value .A value greater than one represent increase in total productivity from period **t** to period **t+1** and the value bellow one represent the decline in total productivity. As it mentioned before, MPI can be decomposed in to measures of technical change and technical efficiency change by factoring as:

$$M_o\,(X_{t+1}, Y^{t}_{+1}, X_t, Y_t) = \left( \frac{D_{t+1}(X_t, Y_t)}{D_{t+1}(X_{t+1}, Y_{t+1})} \right) \left[ \left( \frac{D_{t+1}(X_{t+1}, Y_{t+1})}{D_t(X_{t+1}, Y_{t+1})} \right) \left( \frac{D_{t+1}(X_t, Y_t)}{D_t(X_t, Y_t)} \right) \right] .(8)$$

Where, the first ratio represents the technical efficiency change between the two periods. Both the denominator and nominator of this ratio must be greater than and equal to one .Thus, this ratio is grater one if there is an increase on technical efficiency .If the efficiency decline between the two period, the value of this ratio will be smaller than one.

The second ratio in equation **(8)** is a geometric mean (shift in frontier),representing the technical change between the two period **t** and **t+1** .The value greater than one imply technical progress which value smaller than one imply technical regress. The product of technical efficiency changed and technical change give total productivity change. Several different methods can be used to compute the distance functions which compose the Malmquist TFP index; But to date, the most popular method has been the DEA-based programming method suggested by Färe et al. (1994), which is the method that was followed in our empirical analysis.

## 3.2. Source of Data and Choice of Variables

The data for this study was mainly drawn from various annual reports prepared by the insurance companies and reported to the regulatory body, National Bank of Ethiopia. Besides, secondary data were utilized that obtained from different books, published and unpublished materials and articles.

### 3.2.1. Choice of Variables

To estimate the best practice frontier, inputs and outputs are needed to be identified

**I. Defining and Measuring Output**

Like other financial sector, insurance outputs are intangible and difficult to measure. Thus the alternative way is to search measurable proxies that are highly correlated with the service that insurance companies provide to the insured. There are three principal approaches in financial sector which have been used to measure output namely, the Asset (Intermediation) approach, User Cost approach and Value Added approach (Burger and Hamphery, 1992). The asset approach considers the financial service as pure financial intermediation. This approach is inappropriate for general (non-life) insurances as they provide many services in addition to financial services. The user cost method treats financial products as input or output based on its contribution to revenue of the financial firm. This approach is also inconvenient for the insurance industry because insurance policies consist of many services (such as risk pooling, claim settlement, intermediation etc), which are priced implicitly. The value added approach identifies all assets and liabilities categories rather than distinguishing input from out puts in mutually exclusive way. Insurers collect premiums in advance from their customers and redistribute most of the funds to those policyholders who sustain losses. Consistent with most of the recent literature on financial institution (e.g., Berger and Humphrey, 1992, Berger,Hancock, and Humphrey, 1987,Cummin and Weis,2001), the study adopted a modified version of the value added approach to define outputs of the general insurance, which has been proved to be the most appropriate method to study of insurance efficiency.

As stated by Burger and Hamphery (1997) the main services provided by the insurers are summarized as follow:

- **Risk pooling and risk bearing**:-Insurance provides mechanism for economic agents exposed to insurable contingencies to engage in risk reduction through diversification effect of pooling. The actuarial, underwriting and related expenses incurred in operating the risk pool are major components of value added in insurance industry.
- **Real Financial services relating to the insured loss**: – Insure provide variety of real services for policy holders. These include risk survey to identify loss exposures and design of program to cover this and other risk and recommendations regarding deductible and policy limit. Loss settlement service by the insurer includes valuation of property loss, negotiation with contracts and legal representation for liability claim. By contracting with insurer to provide this

services the insured can take advantage of insurer's extensive experience and specialized expertise to reduce cost associated with insurable risks.

- **Intermediation**:–Insurer collect premium in advance of loss payment and hold the fund and invest until they are needed to pay claim. In return, the policy holders receive a discount in premium they pay to compensate for the opportunity cost of fund held by the insurer. For non-life insurers, financial intermediation is some what incidental function resulting from the collection of premium in advance of claim payment to minimize contract enforcement cost.

Turning to the specification of the variables used to represent insurance outputs in efficiency estimation, there has been considerable disagreement over the appropriate proxies to use for risk–pooling /risk bearing services of insurers. Premium income has been used as proxy for risk bearing and real insurance output by the majority of recent insurance literatures [see for instance ,Grace and Temi(1992), Rai(1996), Domi and Fecher(1997),Hardwick(1997) Domi and Fecher(1997), Boonyasi, Grace and Skipper(2004) ]. In spite of wide acceptance of premium by most insurance literatures, some researchers (example: Yungert, 1993) argued that there is a limitation associated with such measure. Their main consideration is that premium is a form of revenue (price multiplied by quantity). This has led some authors including Cummin, Tenyson and Weis (1999), Cummin and Weis (2000), and Cummins and Santomero (1996) to use the value of loss payment as proxy or quantity of risk pooling and real insurance output. Nevertheless, Berger and Humphery (1997) has argued that taking loss incurred as proxies for output may give inaccurate efficiency estimate during the period where losses are usually catastrophic or other random fluctuation of insurance experiences. He further offered cogent explanation that insurance with very successful underwriting and loss preventions practice will experience few losses for the same premium written but will be measured as having less output and vise versa. Moreover, it is difficult to understand that why insurance companies seek to maximize the value of insurance claim and this therefore, contradict the principle identified by Cooper, Seife and Tone(2002) that more out put should be preferable to less .

The output definition under this study is consistent with those efficiency studies which used total earned premium as their output to approximate risk-pooling /risk bearing services of insurance. Premium represents the most appropriate proxy for output because in addition to the points noted above, premium is highly correlated with expected losses, smooth realization of loss payment by maintaining capacity of risk pooling, and provides an alternative output measure that is less subject to random fluctuations, In addition to earned premium investment income represents the second proxy of insurance output.

## II. Definition and Measurement Inputs

In contrast to output, inputs are easier to identify and measure in insurance industry since the units of measurement are tangible and directly observable. Following the previous insurance literature, this study categorizes the insurance inputs into four groups.

- **Labor input:** Labor is the most important input for insurance industry. All previous studies on insurance efficiency use labor as the main input. Labor input is defined as the total number of persons employed by the insurers which include clericals, management and supervisory staff, surveyor, administrative personnel and others.

- **Business Service and Materials Inputs:** The business service and materials inputs consists of travel and communications expense, loss adjustment expense, stationary and printing , legal fees, advertising expense, agents' commission, ,and cost of physical capital, rental expense and other small expenses. The quantity of material and business service is computed by dividing expenditure on these inputs by consumer price index. This approach is consistent with Cummins and Weis (1998).

- **Financial Capital Input:** Cummins and Weiss (1993) and Cummins and Zi (1998) argued that the capital structure of the insurance industry is quite different from that of manufacturing industries and that an insurance company's capital consists mostly of financial capital. Financial capital is important for risk pooling and risk bearing function because it provides assurance that the company will meet its commitments. Besides satisfying regulatory requirement, the inclusion of financial equity capital of insurance company plays a critical role in reducing firm's insolvent risk. Financial capital is more closely represents the real capital used in producing output. Hence, capital levels ultimately affect the revenue and profit of an insurer. It defined as the sum of legal reserves required by regulatory body and share holders capital.

- **Debt Capital Input:** This input is consists of the fund borrowed from the policy holders. This fund includes the sum of loss reserve and unearned premium reserve. Loss reserve represents the company's obligation for unpaid loss and unearned premium reserve represents premium hold for coverage not expired.

# CHAPTER FOUR

# EMPERICAL RESULTS AND DISCUSSION

## 4.1. Technical Efficiency Score

The full set of results for overall technical efficiency (TE) and scale efficiency (SE) of Ethiopian industry are provided in Table 2, together with the maximum, minimum and mean for the sample period assuming both CRS and VRS (when the frontiers are constructed by CRS and VRS technologies). The first sets of descriptive statistics in table 2 are those relating to the entire sample (i.e. all insurers in the sample). This revealed that during the period from 1996 to 2005 under constant return to scale (CRS) assumption, of the 7 general insurers examined, 3 insurers (nearly 43 percent) including Ethiopian insurance Corporation were technically efficient with an efficiency index equal to one, while 4 insurers (57 percent) were efficient with assumption of variable return to scale (VRS) .

The results of technical efficiency indicates that under constant return to scale (CRS) the average technical efficiency of the industry found 80.50 percent. This result implies that the Ethiopian insurance industry would produce products and services, on average with about 19.50 percent less input if they operate on observable best-practice.

TABLE 2: TECHNICAL EFFICIENCY SCORES FOR THE YEARS 1996 TO 2005 UNDER CRS AND VRS

| Scale Assumption | Variable | ALL INSURERS(N=7) | | | | | WITH OUT ETHIOPIAN INSURANCE CORPORATION(N=6) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | S.D. | Min. | Max | Fully Efficient Firms no. | Mean | S.D. | Min | Max | Fully Efficient Firms no. |
| DEA-CRS | *TE* | *0.805* | *0.175* | *0.577* | *1.00* | 3 | *0.810* | *0.171* | *0.659* | *1.00* | 2 |
| DEA-VRS | *TE* | *0.932* | *0.189* | *0.782* | *1.00* | 4 | *0.920* | *0.170* | *0.782* | *1.00* | 3 |
| | SE | *0.858* | *0.189* | *0.680* | *1.00* | 3 | *0.873* | *0.171* | *0.752* | *1.00* | 2 |

Similarly, the average efficiency score with variable returns to scale assumption is higher than with constant returns to scale (93.20 percent) compared to CRS. This implies that on overage inputs could be reduced to 6.80 percent off the current level if they operate on the best practice production frontier. These levels of average technical inefficiencies were attributable to the fact that some Ethiopian general insurance companies do not seem to be using the most efficient technology available to transform the inputs into outputs.

Analyzing scale efficiency, it appeared from the result that the average scale efficiency of the Ethiopian insurance industry exhibited an average scale efficiency of 85.80 percent with four insurers with scale efficiency of one. Scale efficiency with value equal to unity means optimal scale and a value less than unity mean either too small or too large.

Furthermore, DEA allows assessing whether a firm lies in the range of increasing, constant, and decreasing returns to scale. If a market contains firms operating with increasing and decreasing returns to scale, market efficiency can be increased if more firms attain constant returns to scale, because some resources are wasted due to firms being either too small or too large. The results showed that on average four of the companies within the sample showed increasing returns to scale and three companies exhibited constant returns to scale, highlighting that the majority of the firms in the sample are small.

Generally private insurers as group compared with their counterpart Ethiopian Insurance Corporation appeared as less efficient users of input quantities to produce a given output. Relatively the lower scores for private sector insurers in the sample period could be because these companies were newly established and in the expansion phase.

Excluding Ethiopian Insurance Corporation in the sample, the mean technical efficiency of the industry was 81.00 percent under the assumption of constant returns to scale, whereas the variable returns to scale estimate was again much higher, with a degree of technical efficiency of 92 percent compare to the efficiency results for the entire sample. The high degree of similarity between the efficiency scores of the two sample group would seem to be supportive of arguments that on average EIC technology did not appeared to dominate the small private insurers during the last decade

## 4.2. Malmquist TFP Estimates

Malmquist productivity indices and the decomposition into indices of technical efficiency change and technical change over the sample period are summarized in the table 3 below.

**Table.3. RESULT OF MALMQUIST INDICES: 1996-2005**

| Variable \ Year | | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | Average of 1997-2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Efficiency Change* | Mean | 1.222 | 0.971 | 0.989 | 1.00 | 1.022 | 0.962 | 1.048 | 0.994 | 0.979 | **1.018** |
| | S.D. | 0.028 | 0.032 | 0.063 | 0.095 | 0.092 | 0.064 | 0.050 | 0.039 | 0.062 | **0.059** |
| | Max. | 1.406 | 1.157 | 1.154 | 1.06 | 1.186 | 1.048 | 1.111 | 1.072 | 1.018 | **1.095** |
| | Min. | 1.00 | 0.917 | 0.769 | 0.845 | 0.889 | 0.876 | 1.00 | 0.912 | 0.841 | **0.894** |
| *Technological Change* | Mean | 0.668 | 1.002 | 1.057 | 0.915 | 0.970 | 1.00 | 0.854 | 0.968 | 1.034 | **0.933** |
| | S.D. | 0.028 | 0.034 | 0.060 | 0.094 | 0.097 | 0.063 | 0.055 | 0.033 | 0.088 | **0.085** |
| | Max. | 0.840 | 1.053 | 1.329 | 0.976 | 0.970 | 1.155 | 0.902 | 1.038 | 1.157 | **1.047** |
| | Min. | 1.00 | 0.794 | 0.906 | 0.745 | 1.217 | 0.842 | 0.823 | 0.930 | 0.985 | **0.916** |
| *Total Factor Productivity* | Mean | 0.817 | 0.973 | 1.045 | 0.915 | 0.991 | 0.962 | 0.894 | 0.944 | 1.012 | **0.950** |
| | S.D. | 0.081 | 0.041 | 0.054 | 0.099 | 0.094 | 0.069 | 0.050 | 0.091 | 0.085 | **0.089** |
| | Max. | 1.149 | 1.053 | 1.441 | 0.976 | 1.217 | 1.155 | 0.902 | 1.038 | 0.846 | **1.092** |
| | Min. | 0.535 | 0.794 | 0.906 | 0.819 | 0.865 | 0.842 | 0.835 | 0.898 | 1.157 | **0.850** |

Unlike the efficiency estimates outlined before, which is based on the frontier of an indicated year, the Malmquist indices and its components compare changes across two years period ending in the pointed Years. For instance, the 1997 Malmquist index shows a decline in productivity between 1996 and 1997 by about 18.30 percent. The efficiency change and technical change results for the same year were 1.222 and o.668, respectively. The overall productivity growth which is reflected by the mean Malmquist Index over the 1996-2005 periods was 0.950, signifying annual productivity detoriations of 5 percent in the general insurance industry. The Malmquist indices underlined improvements in productivity only two out of nine years (in 1999 and 2005) and productivity regress in remaining seven years. It is particularly noteworthy that large declines in total productivity occurred in the year1997 and 2003.

The efficiency changes were close to 1.0 in most years with average value of 1.018. These results imply that the technical efficiency change (i.e. use of inputs) of insurers in the Ethiopian insurance industry remained about the same during the sample period. The technical change results demonstrate technological progress in three of the nine years (during 1998, 1999 and 2005) with geometric mean 0.933 for the sample period. Thus, detoriations in productivity over the period seem to have been brought about mainly by a technological regress rather than efficiency loss. The interpretation of the technical change indices is that the technology in the Ethiopian industry now requires more inputs to produce a given output vector than in 1996. This suggests that changes in technology are needed if the industry needs to become more productive.

Looking at descriptive statistics, the low standard deviation total productivity growth and its components implies that there is insignificant variation in efficiency and technological change among the insurance companies.

## 4.3. Second Stage Analysis

In order to give further insight into the variation of technical efficiency scores among individual companies in the industry, a second-stage analysis is conducted, whereby the estimated efficiency scores from the DEA are taken as the independent variable and regressed against the environmental variables .The second stage analysis employed a Tobit model rather than ordinary least squares in order to allow for the restricted [0, 1] range of Farrell efficiency scores. By definition, these environmental variables are not decision variables that would otherwise they have been already included in the firm's choice of the nature or level of inputs and/or outputs). The key environmental (independent) variables that may influence efficiency include the followings.

1. **Company Size (SIZE):** The size of insurance measured by total assets. There are many economic based arguments supporting the relation between efficiency performance and size of insurers. It is noted that large insurance size is likely to perform more efficiently as the realize economy of scale. This variable measured as the natural logarism of total assets.

The logarism helps to eliminate the likely correlation between total assts and inputs or outputs and extreme value in data. The variable $SIZE^2$ is also included in order to pick up any non-linear relationship between size and efficiency.

**2. Liquidity Ratio (LIQ):** Liquidity measure the ability of insurers to fulfill or honor their immediate commitment in due time. This is defined as cash and cash equivalent asset over current liability. The amount of premium written is a better measure than the total amount insured because the level of premium is linked to the likelihood of claims.

3. **Solvency Ratio (SOR):** is measured as the ratio of total insurance fund and earned premium. It measures an insurance company's assets (which it has to pay claims) against the volume of business it does, and therefore the risk from unexpectedly high claims. The solvency ratio measures an insurance company's funds (which it has to pay claims) against the volume of business it does, and therefore the risk from unexpectedly high claims. This also provides measure of how financially sound an insurer is.

**4. Loss Ratio (LR):** loss ratio measures the company's underwriting performance or loss experience. It is defined as the ratio of claim incurred and earned premium.

**Company Type (TYPE):** This represent by dummy variable that take the form 0 for private companies and 1 for the public. The insurance companies vary in their ownership structure i.e. government owned and private owned. The variations in ownership may likely result difference in efficiency level.

**5. Debt Ratio (DR):** Debt ratio is another variable that might have an impact on company's ability to operate efficiently. The debt ratio is measured as the ratio of uncollected premium debt and gross premium.

The estimating equation for the two-stage procedure is given as follow

$$Eff = \beta_0 + \beta_1 \ lnSIZE + \beta_2 LIQ + \beta_3 LR + \beta_4 SOR + \beta_5 + \beta_6 T\ YPE + \beta_7 DR + \beta_7 \ lnSIZE^2 + TYPE + \varepsilon$$

Where: *Eff*=efficiency score, *SIZE*=size, *LIQ*=liquidity, *LR*=loss ratio, *T YPE*=type of company, *DR*= debt ratio, $\varepsilon$ =error term assumed to have a zero mean and constant variance, $\beta_0$ and $\beta_1 \ldots\ldots\ldots \beta_8$ represent parameters for independent variables

The estimates of marginal effects of the explanatory variables on technical efficiency, standard errors and their significance for the Tobit regressions are summarized in Table 4. Dependent variable for the regressions in Table 4 is the DEA measures of technical Efficiency from

VRS, because many firms are operated with increasing to scale during from the sample period. As pointed out earlier the sample included seven general insurance companies over the years 1996 to 2005.

Table 4: Determinants Technical Efficiency of Ethiopian Insurance Industry

| **Variable** | **MARGINAL EFFECTS** | **STANDARD ERROR OF ESTIMATED COFFICIENT** | **P Value** |
|---|---|---|---|
| CR | -0.5457781* | 0.183694 | 0.004 |
| SOR | 0. 2051781** | 0.0857336 | 0.020 |
| LIQ | 0.117789 | 0.0783619 | 0.159 |
| DR | 0.824792 | 0.105944 | 0.439 |
| lnASSET | 0.698311** | 0.3096507 | 0.028 |
| $lnASSET^2$ | -0.0172848** | 0.0081304 | 0.037 |
| TYPE | -0.0195906** | 0.0382362 | 0.075 |
| CONST | -6.1755292** | 2.944999 | 0.040 |
| Log Likelihood Ratio =-15.09, Pseudo $R^2$ = 1.623 | | | |

Note: *Significant at 1% level; ** Significant at 5% level;

In the regression result, it is observed that size (*log of* asset) *is* highly significant and firm size is positively related to TE, suggesting that larger firms are more technically efficient. This strong association between technical efficiency estimates and size of operations reflects improved flexibility of large insurers to arrange the best combination of inputs and outputs and better risk-pooling or industry shock resilience opportunities than their smaller counterparts. The signs on the estimated coefficients for asset sizes, namely *AST* and *AST2*, are positive and negative with the marginal effect on pure technical of 69.83 % and 1.73 % respectively; provide evidence supporting a non-linear relationship between firm size and efficiency. This result supports several economic based arguments that large size insurers are likely to perform better than small insurers because they achieve economy of scale through increasing output.

The ratios of claims paid to premiums appeared negatively and highly significant with marginal effect coefficient of 54.57 %. This result implies that insurers with higher loss ratio tended to be less efficient. Statistically significant and inverse relation between *claim ratio and* technical efficiency suggest companies engaged in low-risk underwriting activities have better technical efficiency performance than companies with high risk underwriting. The higher complexity associated with claims that have longer settlement periods are more susceptible to moral hazard and provides more opportunities for firms to make mistakes in using technology. Furthermore, high annual insurance losses will tend to increase the level of corporate management task ex-post (e.g., claims investigation and loss adjustment) that could further exacerbate a decline in technical efficiency performance. High claim could also be a result of reducing insurance prices below the economic value in response to pressure from competitors in the market which in turn limited management's ability to increase annual premiums and investment income to compensate for losses arising as a result of poorly priced risks.

The coefficients associated to the dummy variable, public and private status is statistically significant with marginal effect of 1.96 percent, which suggests that ownership structure public versus private has an impact on technical efficiency though its magnitude is appeared to be small. This implies private companies are slightly more efficient than Public company. The results therefore confirm that younger companies seem to benefit from being more innovative and able take advantage of more efficient processes and technologies.

Examining the results the composition of the solvency of insurance companies, it becomes obvious that in Ethiopian insurances solvency ratio have found positively related to the level of technical efficiency, with a marginal effect of 20.52%. This relationship suggests that insurance companies with more overall resources and higher capitalization are more likely to adopt best production technology.

The regression result also revealed that liquidity ratio and debt ratio were not found to be significant in influencing the technical efficiency Ethiopian insurance industry.

ratios found as an indicative of a firm's poor performance in technical efficiency. This higher claim ratio could be associated with unhealthy competition which focused on insufficient risk premium. Higher solvency ratio corresponds to higher efficiency performance as a result of better exploitation of financial capacity. The technical efficiency estimates found strongly associated with the size of operations, which supports the economy of scale argument in Ethiopian insurance industry.

## 5.2. POLICY IMPLICATIONS

The findings of this study have some important policy implications. Thus, given the empirical findings presented, the paper forwards the following policy recommendations that help to improve the efficiency and productivity of the Ethiopian insurance sector.

- One of the basic principles of insurance is that the premiums paid by the many should correctly reflect the risk covered. However, this basic principle is threatened in Ethiopian insurance industry .This is mainly due to competitive pressure which is manifested by unsound practices (such as uneconomic pricing, cash-flow underwriting[3] ...). To

[3] *Cash-flow underwriting is defined as an underwriting practice where coverage is provided for a premium level that is less than necessary to pay claims and expenses*

# CHAPTER FIVE

# CONCLUSION AND POLICY IMPLICATIONS

## 5.1. CONCLUSION

Efficiency and productivity is at the heart of the operation of the insurance sector and underpins the prospect for insurers to contribute effectively to the development of financial sector and the economy as the whole. This study examined technical efficiency and productivity of the Ethiopian insurance using modern frontier and Malmquest Productivity Index to measure the technical efficiency and productivity performance of the industry over ten years sample period (1996 to 2005). The sample included data on seven insurance. The "best practice" production frontiers are estimated by adopting input-oriented distance functions using data envelopment analysis (DEA) and the productivity growth is measured using Malmquist index methodology,

The estimated results of technical efficiency scores indicated that the Ethiopian insurance sector on average seem to be not using the most efficient technology, thereby preventing the most efficient transformation of inputs into outputs due to a general overuse, or wasting of inputs relative what could be considered optimal usage based on observable best practice. Thus, there still exists an opportunity for expanding output in the industry by increasing industry's efficiency level and management abilities of utilizing existing resources and technology. It is also evident from the study that most companies in the Ethiopian insurance industry are not operating at an optimal scale (rather under increasing returns to scale). As a result, efficiency gains could be achieved by fostering growth of small insurers together with expansion of the market.

The Malmquist analysis showed that the industry experienced productivity loss over the sample period, implying that the insurers needed more inputs to produce their outputs at the end of the sample period than at the beginning. Although improvements in both technical efficiency and technical change appeared to be needed, the main problem for the average firms was technological regress. This suggests low resources were devoted to technical change by most insurance company in the industry during the last decade and there remains a potential for productivity growth in the Ethiopian insurance industry.

To find factors that affect efficiency of insurers, the paper also conducted an ex-post regression analysis (Tobit regression) with the technical efficiency scores as dependent variables and various firm characteristics as independent variables. The Tobit analysis provides evidence that the claim ratio, solvency ratio and size of a company are vital factors to explain the level efficiency in Ethiopian insurance industry. High claim prevent the continuing adverse effect on the structure of the market from the existence of lethargic practice that spoil the market through the charging of uneconomic premiums, the insurance supervisory authorities should give greater consideration to assess the financial soundness of insurers as well as design mechanisms for intervention so as to safeguard interests of insurance consumers.

- Adequate financial capital not only enables insurance companies to pool risks and to maintain stable underwriting results by spreading risks but also assists in augmenting the efficiency and productivity of the insurers. The insurance fund of some small existing private insurers however, seems not adequate. Thus, the supervisory body should carefully examine efficiency and productivity gains by increasing minimum capital requirement and strengthening their solvency.

- The development of the insurance industry is very much dependent on the level of awareness among the public which in turn result in efficiency and productivity improvements of the industry. Hence, it is strongly recommended that the insurance companies need to make systematic and continuous awareness creation efforts to enlighten the public about the benefit and importance of insurance. The efficiency and productivity of insurance industry can also be enhanced by utilization of information technology. This can complement distribution channel and performance efficiency. The use of data management and mining can gauge efficiency and this in turn results in profitability in the industry. Besides, it will allow for better understanding of customers behavior which will help to determine price correctly and increase productivity.

- Finally, human resource development is another aspect that needs to be addressed since qualified and competent manpower in the insurance industry will enhance the practice of prudent underwriting. Without competent workforces, it is difficult to improve efficiency and productivity of the industry. Thus, the modernization and development of the insurance industry would require a major effort in upgrading the skills and competency of manpower. Moreover, the supervisory organ needs to enhance its supervisory capacity by acquiring highly specialized experts which build up the supervisor's ability to monitor reserves, pricing adequacy, and solvency requirements.

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ANNEX.1

Summary of Efficiecy Score:1996-2005

Results from DEAP Version 2.1

Instruction file = $$TEMP$$.INS
Data file = $$TEMP$$.DTA

Input orientated DEA

Scale assumption: VRS

Slacks calculated using multi-stage method

EFFICIENCY SUMMARY:

| firm | crste | vrste | scale |
|---|---|---|---|
| 1 | 1.000 | 1.000 | 1.000 - |
| 2 | 1.000 | 1.000 | 1.000 - |
| 3 | 0.680 | 1.000 | 0.680 irs |
| 4 | 0.631 | 0.868 | 0.728 irs |
| 5 | 0.577 | 0.782 | 0.738 irs |
| 6 | 1.000 | 1.000 | 1.000 - |
| 7 | 0.748 | 0.873 | 0.857 irs |
| Mean | 0.805 | 0.932 | 0.858 |

Note: crste = technical efficiency from CRS DEA
vrste = technical efficiency from VRS DEA
scale = scale efficiency = crste/vrste

Note also that all subsequent tables refer to VRS results

SUMMARY OF OUTPUT SLACKS:

| firm | output: | 1 | 2 |
|---|---|---|---|
| 1 | | 0.000 | 0.000 |

| | | | |
|---|---|---|---|
| 2 | | 0.000 | 0.000 |
| 3 | | 0.000 | 0.000 |
| 4 | | 2370552.881 | 418183.046 |
| 5 | 3206225.141 | 1120053.468 | |
| 6 | 0.000 | 0.000 | |
| 7 | 1213498.467 | 424633.512 | |
| mean | 970039.498 | 280410.004 | |

SUMMARY OF INPUT SLACKS:

| firm | input: 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2 | 0.000 | 0.000 | 0.000 | 0.000 |
| 3 | 0.000 | 0.000 | 0.000 | 0.000 |
| 4 | 0.000 | 0.000 | 1547365.717 | 359752.144 |
| 5 | 0.000 | 0.000 | 1044718.162 | 0.000 |
| 6 | 0.000 | 0.000 | 0.000 | 0.000 |
| 7 | 0.000 | 0.000 | 8133707.313 | 1103821.56 |
| mean | 0.000 | 0.000 | 1532255.885 | 209081.958 |

ANNEX.2

Summary of Efficiency Score After Excludin EIC:1996-2005

Results from DEAP Version 2.1

Instruction file = $$TEMP$$.INS
Data file = $$TEMP$$.DTA

Input orientated DEA

Scale assumption: VRS

Slacks calculated using multi-stage method

EFFICIENCY SUMMARY:

| firm | crste | vrste | scale | |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | 1.000 | - |
| 2 | 0.836 | 1.000 | 0.836 | irs |
| 3 | 0.659 | 0.868 | 0.759 | irs |
| 4 | 0.588 | 0.782 | 0.752 | irs |
| 5 | 1.000 | 1.000 | 1.000 | - |
| 6 | 0.776 | 0.873 | 0.889 | irs |
| mean | 0.810 | 0.920 | 0.873 | |

Note: crste = technical efficiency from CRS DEA
vrste = technical efficiency from VRS DEA
scale = scale efficiency = crste/vrste

Note also that all subsequent tables refer to VRS results

SUMMARY OF OUTPUT SLACKS:

| firm | output: | 1 | 2 |
|---|---|---|---|
| 1 | | 0.000 | 0.000 |
| 2 | | 0.000 | 0.000 |

| | | |
|---|---|---|
| 3 | 2370552.881 | 418183.046 |
| 4 | 3206225.141 | 1120053.468 |
| 5 | 0.000 | 0.000 |
| 6 | 1213498.467 | 424633.512 |
| mean | 1131712.748 | 327145.00 |

SUMMARY OF INPUT SLACKS:

| firm | input: | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 1 | | 0.000 | 0.000 | 0.000 | 0.000 |
| 2 | | 0.000 | 0.000 | 0.000 | 0.000 |
| 3 | | 0.000 | 0.000 | 1547365.717 | 359752.144 |
| 4 | | 0.000 | 0.000 | 1044718.162 | 0.000 |
| 5 | | 0.000 | 0.000 | 0.000 | 0.000 |
| 6 | | 0.000 | 0.000 | 8133707.313 | 1103821.563 |
| mean | | 0.000 | 0.000 | 1787631.865 | 243928.951 |

ANNEX.3

Estimate of Malmquest Index:1996;2005

Results from DEAP Version 2.1

Instruction file = $$TEMP$$.INS
Data file = $$TEMP$$.DTA

Input orientated Malmquist DEA

DISTANCES SUMMARY

year = 1

| firm no. | crs te rel to tech in yr t-1 | t | t+1 | vrs te |
|---|---|---|---|---|
| 1 | 0.000 | 0.892 | 1.725 | 0.999 |
| 2 | 0.000 | 0.881 | 3.179 | 1.000 |
| 3 | 0.000 | 0.594 | 0.825 | 0.680 |
| 4 | 0.000 | 0.551 | 0.993 | 0.631 |
| 5 | 0.000 | 0.504 | 0.749 | 0.577 |
| 6 | 0.000 | 0.891 | 1.000 | 0.749 |
| 7 | 0.000 | 0.53 | 0.748 | 0.478 |
| mean | 0.000 | 0.638 | 2.242 | 0.802 |

year = 2

| firm no. | crs te rel to tech in yr t-1 | t | t+1 | vrs te |
|---|---|---|---|---|
| 1 | 1.145 | 0.890 | 1.053 | 1.000 |
| 2 | 0.911 | 0.891 | 1.206 | 1.000 |
| 3 | 0.819 | 0.836 | 0.877 | 0.957 |
| 4 | 0.723 | 0.820 | 0.853 | 0.939 |
| 5 | 0.677 | 0.658 | 0.843 | 0.802 |

| | | | | |
|---|---|---|---|---|
| 6 | 1.518 | 0.843 | 1.672 | 1.000 |
| 7 | 0.859 | 0.810 | 1.000 | 1.000 |
| mean | 0.950 | 0.821 | 1.102 | 0.963 |

year = 3

| firm no. | crs te rel to tech in yr *********************** | | | vrs te |
|---|---|---|---|---|
| | t-1 | t | t+1 | |
| 1 | 1.167 | 0.935 | 1.262 | 1.000 |
| 2 | 1.076 | 0.932 | 1.077 | 1.000 |
| 3 | 0.969 | 0.842 | 0.721 | 0.922 |
| 4 | 0.933 | 0.790 | 0.784 | 1.000 |
| 5 | 0.811 | 0.705 | 0.613 | 0.772 |
| 6 | 1.054 | 0.910 | 1.176 | 1.000 |
| 7 | 1.382 | 0.916 | 1.289 | 1.000 |
| mean | 1.056 | 0.855 | 0.989 | 0.937 |

year = 4

| firm no. | crs te rel to tech in yr *********************** | | | vrs te |
|---|---|---|---|---|
| | t-1 | t | t+1 | |
| 1 | 1.357 | 0.910 | 1.243 | 1.000 |
| 2 | 0.871 | 0.878 | 1.009 | 0.962 |
| 3 | 1.381 | 0.865 | 1.373 | 1.000 |
| 4 | 1.083 | 0.885 | 1.036 | 0.998 |
| 5 | 0.758 | 0.542 | 0.793 | 0.594 |
| 6 | 1.007 | 0.900 | 1.091 | 1.000 |
| 7 | 1.059 | 0.876 | 1.132 | 1.000 |
| mean | 1.074 | 0.836 | 1.097 | 0.936 |

year = 5

| firm no. | crs te rel to tech in yr *********************** | | | vrs te |
|---|---|---|---|---|
| | t-1 | t | t+1 | |
| 1 | 1.015 | 0.934 | 1.188 | 1.000 |
| 2 | 0.961 | 0.543 | 0.893 | 0.594 |
| 3 | 1.088 | 0.932 | 1.272 | 1.000 |
| 4 | 0.823 | 0.769 | 1.003 | 0.843 |

| | | | | |
|---|---|---|---|---|
| 5 | 0.517 | 0.638 | 0.724 | 1.000 |
| 6 | 1.038 | 0.933 | 1.042 | 1.000 |
| 7 | 1.075 | 0.932 | 1.306 | 1.000 |
| mean | 0.931 | 0.849 | 1.061 | 0.930 |

year = 6

| firm no. | crs te rel to tech in yr ************************ t-1 | t | t+1 | vrs te |
|---|---|---|---|---|
| 1 | 1.009 | 0.886 | 1.001 | 1.000 |
| 2 | 0.861 | 0.860 | 0.837 | 0.860 |
| 3 | 0.951 | 0.689 | 1.030 | 1.000 |
| 4 | 0.909 | 0.943 | 1.033 | 1.000 |
| 5 | 0.754 | 0.674 | 0.719 | 0.774 |
| 6 | 1.542 | 0.932 | 1.588 | 1.000 |
| 7 | 1.158 | 0.932 | 1.136 | 1.000 |
| mean | 1.026 | 0.842 | 1.049 | 0.948 |

year = 7

| firm no. | crs te rel to tech in yr ************************ t-1 | t | t+1 | vrs te |
|---|---|---|---|---|
| 1 | 1.335 | 0.932 | 1.179 | 1.000 |
| 2 | 0.866 | 0.901 | 1.069 | 0.901 |
| 3 | 0.955 | 0.735 | 1.122 | 1.000 |
| 4 | 0.876 | 0.688 | 1.061 | 1.000 |
| 5 | 0.737 | 0.577 | 0.775 | 0.677 |
| 6 | 1.126 | 0.893 | 1.234 | 1.000 |
| 7 | 1.103 | 0.881 | 1.311 | 1.000 |
| mean | 1.000 | 0.801 | 1.107 | 0.939 |

year = 8

| firm no. | crs te rel to tech in yr ************************ t-1 | t | t+1 | vrs te |
|---|---|---|---|---|
| 1 | 0.959 | 0.893 | 1.302 | 1.000 |
| 2 | 0.870 | 0.843 | 1.079 | 1.000 |
| 3 | 0.811 | 0.798 | 0.986 | 0.999 |
| 4 | 0.781 | 0.832 | 1.010 | 0.933 |

| | | | | |
|---|---|---|---|---|
| 5 | 0.661 | 0.657 | 0.742 | 0.752 |
| 6 | 0.890 | 0.887 | 1.125 | 1.000 |
| 7 | 0.915 | 0.921 | 1.106 | 1.000 |
| mean | 0.841 | 0.833 | 1.050 | 0.952 |

year = 9

| firm no. | crs te rel to tech in yr<br>************************<br>t-1 | <br><br>t | <br><br>t+1 | vrs te |
|---|---|---|---|---|
| 1 | 1.160 | 0.821 | 1.183 | 1.000 |
| 2 | 0.959 | 0.882 | 0.968 | 0.982 |
| 3 | 0.969 | 0.678 | 1.006 | 1.000 |
| 4 | 0.936 | 0.658 | 1.017 | 1.000 |
| 5 | 0.656 | 0.586 | 0.687 | 0.686 |
| 6 | 1.212 | 0.756 | 1.000 | 1.000 |
| 7 | 0.985 | 0.925 | 1.052 | 1.000 |
| mean | 0.982 | 0.758 | 0.988 | 0.952 |

year = 10

| firm no. | crs te rel to tech in yr<br>************************<br>t-1 | <br><br>t | <br><br>t+1 | vrs te |
|---|---|---|---|---|
| 1 | 1.148 | 0.843 | 0.000 | 1.000 |
| 2 | 1.040 | 0.865 | 0.000 | 1.000 |
| 3 | 1.005 | 0.778 | 0.000 | 0.989 |
| 4 | 0.864 | 0.741 | 0.000 | 0.841 |
| 5 | 0.702 | 0.796 | 0.000 | 0.696 |
| 6 | 1.128 | 0.864 | 0.000 | 1.000 |
| 7 | 1.408 | 0.832 | 0.000 | 1.000 |
| mean | 1.042 | 0.817 | 0.000 | 0.817 |

[Note that t-1 in year 1 and t+1 in the final year are not defined]

MALMQUIST INDEX SUMMARY

year = 2

firm effch techch pech sech tfpch

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1.000 | 0.815 | 1.000 | 1.000 | 0.815 |
| 2 | 1.000 | 0.535 | 1.000 | 1.000 | 0.535 |
| 3 | 1.406 | 0.840 | 1.000 | 1.406 | 1.182 |
| 4 | 1.488 | 0.699 | 1.153 | 1.291 | 1.041 |
| 5 | 1.459 | 0.787 | 1.278 | 1.141 | 1.149 |
| 6 | 1.000 | 0.483 | 1.000 | 1.000 | 0.483 |
| 7 | 1.336 | 0.611 | 1.146 | 1.167 | 0.817 |
| mean | 1.222 | 0.668 | 1.078 | 1.134 | 0.817 |

year = 3

| firm | effch | techch | pech | sech | tfpch |
|---|---|---|---|---|---|
| 1 | 1.000 | 1.053 | 1.000 | 1.000 | 1.053 |
| 2 | 1.000 | 0.945 | 1.000 | 1.000 | 0.945 |
| 3 | 0.964 | 1.070 | 1.000 | 0.964 | 1.032 |
| 4 | 0.921 | 1.090 | 1.000 | 0.921 | 1.004 |
| 5 | 0.917 | 1.050 | 1.000 | 0.917 | 0.963 |
| 6 | 1.000 | 0.794 | 1.000 | 1.000 | 0.794 |
| 7 | 1.000 | 1.052 | 1.000 | 1.000 | 1.052 |
| mean | 0.971 | 1.002 | 1.000 | 0.971 | 0.973 |

year = 4

| firm | effch | techch | pech | sech | tfpch |
|---|---|---|---|---|---|
| 1 | 1.000 | 1.037 | 1.000 | 1.000 | 1.037 |
| 2 | 0.962 | 0.917 | 1.000 | 0.962 | 0.882 |
| 3 | 1.084 | 1.329 | 1.000 | 1.084 | 1.441 |
| 4 | 1.154 | 1.094 | 1.000 | 1.154 | 1.263 |
| 5 | 0.769 | 1.269 | 1.000 | 0.769 | 0.975 |
| 6 | 1.000 | 0.926 | 1.000 | 1.000 | 0.926 |
| 7 | 1.000 | 0.906 | 1.000 | 1.000 | 0.906 |
| mean | 0.989 | 1.057 | 1.000 | 0.989 | 1.045 |

year = 5

| firm | effch | techch | pech | sech | tfpch |
|---|---|---|---|---|---|
| 1 | 1.000 | 0.903 | 1.000 | 1.000 | 0.903 |
| 2 | 1.006 | 0.973 | 1.000 | 1.006 | 0.979 |
| 3 | 1.000 | 0.890 | 1.000 | 1.000 | 0.890 |
| 4 | 0.845 | 0.970 | 1.000 | 0.845 | 0.819 |

| | | | | | |
|---|---|---|---|---|---|
| 5 | 1.177 | 0.745 | 1.000 | 1.177 | 0.876 |
| 6 | 1.000 | 0.976 | 1.000 | 1.000 | 0.976 |
| 7 | 1.000 | 0.974 | 1.000 | 1.000 | 0.974 |
| mean | 1.000 | 0.915 | 1.000 | 1.000 | 0.915 |

year = 6

| firm | effch | techch | pech | sech | tfpch |
|---|---|---|---|---|---|
| 1 | 1.000 | 0.921 | 1.000 | 1.000 | 0.921 |
| 2 | 0.889 | 1.041 | 0.962 | 0.924 | 0.925 |
| 3 | 1.000 | 0.865 | 1.000 | 1.000 | 0.865 |
| 4 | 1.186 | 0.875 | 1.000 | 1.186 | 1.037 |
| 5 | 1.107 | 0.970 | 1.000 | 1.107 | 1.074 |
| 6 | 1.000 | 1.217 | 1.000 | 1.000 | 1.217 |
| 7 | 1.000 | 0.941 | 1.000 | 1.000 | 0.941 |
| mean | 1.022 | 0.970 | 0.995 | 1.028 | 0.991 |

year = 7

| firm | effch | techch | pech | sech | tfpch |
|---|---|---|---|---|---|
| 1 | 1.000 | 1.155 | 1.000 | 1.000 | 1.155 |
| 2 | 1.048 | 0.994 | 1.039 | 1.009 | 1.042 |
| 3 | 0.935 | 0.996 | 1.000 | 0.935 | 0.931 |
| 4 | 0.888 | 0.978 | 1.000 | 0.888 | 0.868 |
| 5 | 0.876 | 1.082 | 1.000 | 0.876 | 0.947 |
| 6 | 1.000 | 0.842 | 1.000 | 1.000 | 0.842 |
| 7 | 1.000 | 0.985 | 1.000 | 1.000 | 0.985 |
| mean | 0.962 | 1.000 | 1.006 | 0.957 | 0.962 |

year = 8

| firm | effch | techch | pech | sech | tfpch |
|---|---|---|---|---|---|
| 1 | 1.000 | 0.902 | 1.000 | 1.000 | 0.902 |
| 2 | 1.110 | 0.856 | 1.000 | 1.110 | 0.950 |
| 3 | 1.069 | 0.823 | 1.000 | 1.069 | 0.879 |
| 4 | 1.051 | 0.837 | 1.000 | 1.051 | 0.879 |
| 5 | 1.111 | 0.876 | 1.000 | 1.111 | 0.973 |
| 6 | 1.000 | 0.849 | 1.000 | 1.000 | 0.849 |
| 7 | 1.000 | 0.835 | 1.000 | 1.000 | 0.835 |
| mean | 1.048 | 0.854 | 1.000 | 1.048 | 0.894 |

year = 9

| firm | effch | techch | pech | sech | tfpch |
|---|---|---|---|---|---|
| 1 | 1.000 | 0.944 | 1.000 | 1.000 | 0.944 |
| 2 | 0.982 | 0.951 | 1.000 | 0.982 | 0.934 |
| 3 | 1.001 | 0.990 | 1.000 | 1.001 | 0.992 |
| 4 | 1.072 | 1.000 | 1.072 | 0.997 | 0.998 |
| 5 | 0.912 | 0.984 | 1.000 | 0.912 | 0.898 |
| 6 | 1.000 | 1.038 | 1.000 | 1.000 | 1.038 |
| 7 | 1.000 | 0.944 | 1.000 | 1.000 | 0.944 |
| mean | 0.994 | 0.968 | 1.000 | 0.994 | 0.963 |

year = 10

| firm | effch | techch | pech | sech | tfpch |
|---|---|---|---|---|---|
| 1 | 1.000 | 0.985 | 1.000 | 1.000 | 0.985 |
| 2 | 1.018 | 1.027 | 1.000 | 1.018 | 1.046 |
| 3 | 0.989 | 1.005 | 1.000 | 0.989 | 0.994 |
| 4 | 0.841 | 1.005 | 1.000 | 0.841 | 0.846 |
| 5 | 1.014 | 1.004 | 1.000 | 1.014 | 1.019 |
| 6 | 1.000 | 1.062 | 1.000 | 1.000 | 1.062 |
| 7 | 1.000 | 1.157 | 1.000 | 1.000 | 1.157 |
| mean | 0.979 | 1.034 | 1.000 | 0.979 | 1.012 |

MALMQUIST INDEX SUMMARY OF ANNUAL MEANS

| year | effch | techch | pech | sech | tfpch |
|---|---|---|---|---|---|
| 2 | 1.222 | 0.668 | 1.078 | 1.134 | 0.817 |
| 3 | 0.971 | 1.002 | 1.000 | 0.971 | 0.973 |
| 4 | 0.989 | 1.057 | 1.000 | 0.989 | 1.045 |
| 5 | 1.000 | 0.915 | 1.000 | 1.000 | 0.915 |
| 6 | 1.022 | 0.970 | 0.995 | 1.028 | 0.991 |
| 7 | 0.962 | 1.000 | 1.006 | 0.957 | 0.962 |
| 8 | 1.048 | 0.854 | 1.000 | 1.048 | 0.894 |
| 9 | 0.994 | 0.968 | 1.000 | 0.994 | 0.963 |
| 10 | 0.979 | 1.034 | 1.000 | 0.979 | 1.012 |

| mean | 1.018 | 0.933 | 1.008 | 1.010 | 0.950 |
|---|---|---|---|---|---|

MALMQUIST INDEX SUMMARY OF FIRM MEANS

| firm | effch | techch | pech | sech | tfpch |
|---|---|---|---|---|---|
| 1 | 1.000 | 0.964 | 1.000 | 1.000 | 0.964 |
| 2 | 1.000 | 0.901 | 1.000 | 1.000 | 0.901 |
| 3 | 1.042 | 0.969 | 1.000 | 1.042 | 1.010 |
| 4 | 1.032 | 0.934 | 1.016 | 1.016 | 0.964 |
| 5 | 1.021 | 0.963 | 1.028 | 0.994 | 0.983 |
| 6 | 1.000 | 0.885 | 1.000 | 1.000 | 0.885 |
| 7 | 1.033 | 0.922 | 1.015 | 1.017 | 0.952 |
| mean | 1.018 | 0.933 | 1.008 | 1.010 | 0.950 |

[Note that all Malmquist index averages are geometric means]

Annex 4.Data of VRS-Efficiency Scores and Enviromental variables

| Company | Year | Efficiency Score | ASSET | CR | LR | SR | DR | Ln Asset | Ln Asse Sq. | DV |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1996 | 0.98 | 468,237,300 | 0.51 | 1.65 | 2.01 | 0.55 | 19.9644858 | 398.5806923 | 1.00 |
| 1 | 1997 | 1 | 483,162,300 | 0.44 | 1.95 | 1.96 | 0.60 | 19.9958632 | 399.8345443 | 1.00 |
| 1 | 1998 | 1 | 510,746,400 | 0.34 | 1.93 | 2.03 | 0.61 | 20.0513837 | 402.0579900 | 1.00 |
| 1 | 1999 | 1 | 510,338,800 | 0.42 | 1.64 | 2.46 | 0.61 | 20.0505854 | 402.0259740 | 1.00 |
| 1 | 2000 | 1 | 512,901,000 | 0.4 | 1.86 | 1.95 | 0.52 | 20.0555934 | 402.2268267 | 1.00 |
| 1 | 2001 | 1 | 534,993,700 | 0.38 | 1.90 | 1.84 | 0.75 | 20.09776553 | 403.9201793 | 1.00 |
| 1 | 2002 | 1 | 616,849,000 | 0.43 | 1.88 | 2.22 | 1.01 | 20.2401348 | 409.6630575 | 1.00 |
| 1 | 2003 | 1 | 630,038,000 | 0.36 | 1.94 | 2.11 | 0.78 | 20.2612907 | 410.5199005 | 1.00 |
| 1 | 2004 | 1 | 626,850,100 | 0.39 | 1.91 | 1.95 | 0.60 | 20.2562180 | 410.3143675 | 1.00 |
| 1 | 2005 | 1 | 640924381 | 0.35 | 1.94 | 1.87 | 0.58 | 20.27842204 | 411.2144003 | 1.00 |
| 2 | 1996 | 1 | 34,180,663 | 0.42 | 2.00 | 1.98 | 0.34 | 17.3471706 | 300.9243290 | 0.00 |
| 2 | 1997 | 1 | 39,449,890 | 0.41 | 2.38 | 1.89 | 0.39 | 17.4905418 | 305.9190530 | 0.00 |
| 2 | 1998 | 1 | 44,990,650 | 0.38 | 2.93 | 1.45 | 0.33 | 17.6219652 | 310.5336592 | 0.00 |
| 2 | 1999 | 0.962 | 64,278,450 | 0.45 | 1.58 | 1.36 | 0.52 | 17.8096378 | 317.1831999 | 0.00 |
| 2 | 2000 | 0.967 | 63,862,180 | 0.5 | 1.57 | 1.13 | 0.61 | 17.9722379 | 323.0013345 | 0.00 |
| 2 | 2001 | 0.98 | 71,160,574 | 0.55 | 1.47 | 0.98 | 0.55 | 18.0804495 | 326.9026537 | 0.00 |
| 2 | 2002 | 1 | 78,272,480 | 0.44 | 1.78 | 1.04 | 0.69 | 18.17570663 | 330.3563115 | 0.00 |
| 2 | 2003 | 0.97 | 83,421,250 | 0.49 | 2.05 | 1.47 | 0.78 | 18.23941351 | 332.6762052 | 0.00 |
| 2 | 2004 | 0.982 | 63,983,510 | 0.46 | 1.59 | 1.12 | 0.57 | 17.93993688 | 321.8413351 | 0.00 |
| 2 | 2005 | 1 | 61,832,327 | 0.41 | 2.40 | 1.37 | 0.56 | 17.93993688 | 321.8413351 | 0.00 |
| 3 | 1996 | 0.68 | 15,051,948 | 0.63 | 1.99 | 0.55 | 0.40 | 16.52701798 | 273.1423232 | 0.00 |
| 3 | 1997 | 0.957 | 23,334,169 | 0.43 | 1.43 | 0.67 | 0.49 | 16.96542932 | 287.8257922 | 0.00 |
| 3 | 1998 | 0.922 | 31,972,838 | 0.49 | 1.88 | 1.05 | 0.42 | 17.28039729 | 298.6121304 | 0.00 |
| 3 | 1999 | 1 | 37,699,549 | 0.38 | 2.01 | 1.11 | 0.60 | 17.44515869 | 304.3335617 | 0.00 |
| 3 | 2000 | 1 | 51,104,656 | 0.44 | 1.66 | 1.02 | 0.62 | 17.74938617 | 315.0407093 | 0.00 |
| 3 | 2001 | 1 | 49,227,318 | 0.41 | 1.56 | 1.10 | 0.32 | 20.01454464 | 400.5819973 | 0.00 |
| 3 | 2002 | 0.935 | 58,009,188 | 0.48 | 1.72 | 1.01 | 0.35 | 17.87611197 | 319.5553792 | 0.00 |
| 3 | 2003 | 0.999 | 53,564,876 | 0.59 | 1.66 | 0.95 | 0.65 | 17.79640411 | 316.7119993 | 0.00 |

| Company | Year | Efficiency Score | ASSET | CR | LR | SR | DR | Ln Asset | Ln Asse Sq. | DV |
|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 2004 | 1 | 48,289,765 | 0.67 | 1.89 | 1.19 | 0.45 | 17.69273019 | 313.0327016 | 0.00 |
| 3 | 2005 | 0.989 | 52,808,222 | 0.73 | 1.54 | 0.98 | 0.21 | 17.76305942 | 315.5262800 | 0.00 |
| 4 | 1996 | 0.631 | 20,048,065 | 0.45 | 1.58 | 0.92 | 0.21 | 16.8136432 | 282.6985976 | 0.00 |
| 4 | 1997 | 0.939 | 34,146,290 | 0.37 | 2.51 | 1.30 | 0.35 | 17.3461645 | 300.8894229 | 0.00 |
| 4 | 1998 | 0.865 | 37,608,597 | 0.41 | 1.60 | 1.04 | 0.60 | 17.44274323 | 304.2492912 | 0.00 |
| 4 | 1999 | 0.998 | 39,824,670 | 0.40 | 1.99 | 0.93 | 0.60 | 17.4999971 | 306.2498995 | 0.00 |
| 4 | 2000 | 0.843 | 44,319,985 | 0.55 | 1.79 | 1.01 | 0.57 | 20.66597563 | 427.0825489 | 0.00 |
| 4 | 2001 | 1 | 69,254,554 | 0.5 | 2.04 | 1.08 | 0.62 | 22.65991402 | 513.4717033 | 0.00 |
| 4 | 2002 | 0.888 | 76,611,061 | 0.58 | 1.87 | 1.13 | 0.65 | 18.15425202 | 329.5768665 | 0.00 |
| 4 | 2003 | 0.933 | 82,611,061 | 0.49 | 1.85 | 1.03 | 0.66 | 18.22965414 | 332.3202901 | 0.00 |
| 4 | 2004 | 1 | 65,772,084.00 | 0.41 | 1.69 | 1.13 | 0.53 | 18.00170605 | 324.0614207 | 0.00 |
| 4 | 2005 | 0.841 | 61,443,299 | 0.58 | 1.48 | 0.95 | 0.43 | 20.23621043 | 409.5042127 | 0.00 |
| 5 | 1996 | 0.577 | 15,885,423 | 0.71 | 1.55 | 0.52 | 0.60 | 16.5809754 | 274.9287453 | 0.00 |
| 5 | 1997 | 0.843 | 18,602,843 | 0.47 | 1.62 | 0.49 | 0.35 | 16.73882498 | 280.1882616 | 0.00 |
| 5 | 1998 | 0.772 | 20,452,023 | 0.55 | 1.58 | 0.78 | 0.62 | 16.83359236 | 283.3698317 | 0.00 |
| 5 | 1999 | 0.594 | 20,789,218 | 0.65 | 1.54 | 0.72 | 0.42 | 16.84994504 | 283.9206480 | 0.00 |
| 5 | 2000 | 0.699 | 18,191,935 | 0.7 | 1.69 | 0.81 | 0.65 | 16.71648892 | 279.4410019 | 0.00 |
| 5 | 2001 | 0.744 | 18,300,128 | 0.55 | 1.57 | 0.85 | 0.51 | 16.72241861 | 279.6392842 | 0.00 |
| 5 | 2002 | 0.677 | 19,673,675 | 0.57 | 1.51 | 0.82 | 0.60 | 16.79479201 | 282.0650385 | 0.00 |
| 5 | 2003 | 0.752 | 21,538,924 | 0.58 | 1.81 | 1.05 | 0.15 | 16.88537227 | 285.1157969 | 0.00 |
| 5 | 2004 | 0.686 | 24,446,584 | 0.63 | 1.70 | 0.95 | 0.57 | 17.01200105 | 289.4081797 | 0.00 |
| 5 | 2005 | 0.696 | 25581635 | 0.7 | 1.38 | 0.52 | 0.39 | 17.05738527 | 290.9543922 | 0.00 |
| 6 | 1996 | 1 | 9,099,800 | 0.33 | 2.90 | 3.88 | 0.49 | 16.02376299 | 256.7609805 | 0.00 |
| 6 | 1997 | 1 | 16,265,130 | 0.31 | 3.20 | 3.08 | 0.23 | 16.60453466 | 275.7105714 | 0.00 |
| 6 | 1998 | 1 | 18,602,840 | 0.35 | 2.53 | 1.95 | 0.15 | 16.73882482 | 280.1882562 | 0.00 |
| 6 | 1999 | 1 | 20,452,840 | 0.42 | 2.84 | 1.66 | 0.62 | 16.84994466 | 283.9206350 | 0.00 |
| 6 | 2000 | 1 | 20,789,210 | 0.40 | 2.45 | 1.96 | 0.72 | 16.84994509 | 283.9206496 | 0.00 |
| 6 | 2001 | 1 | 19,663,700 | 0.41 | 2.52 | 1.83 | 0.67 | 16.79428485 | 282.0480038 | 0.00 |
| 6 | 2002 | 1 | 20,122,528 | 0.40 | 2.32 | 1.22 | 0.79 | 16.81735054 | 282.8232792 | 0.00 |

| Company | Year | Efficiency Score | ASSET | CR | LR | SR | DR | Ln Asset | Ln Asse Sq. | DV |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 2003 | 1 | 21,538,924 | 0.42 | 2.01 | 1.57 | 0.70 | 16.88537227 | 285.1157969 | 0.00 |
| 6 | 2004 | 1 | 24,446,583 | 0.41 | 2.07 | 1.58 | 0.65 | 17.01200101 | 289.4081783 | 0.00 |
| 6 | 2005 | 1 | 25,581,635 | 0.26 | 1.88 | 1.49 | 0.54 | 17.05738527 | 290.9543922 | 0.00 |
| 7 | 1996 | 0.748 | 38,570,900 | 0.51 | 1.74 | 1.05 | 0.32 | 17.46800866 | 305.1313267 | 0.00 |
| 7 | 1997 | 1 | 56,319,275 | 0.37 | 2.30 | 1.21 | 0.28 | 17.8465474 | 318.4992540 | 0.00 |
| 7 | 1998 | 1 | 65,546,600 | 0.38 | 2.31 | 1.5 | 0.38 | 17.9982719 | 323.9377913 | 0.00 |
| 7 | 1999 | 1 | 98,674,600 | 0.48 | 2.12 | 1.32 | 0.49 | 18.40733813 | 338.8300969 | 0.00 |
| 7 | 2000 | 1 | 102,338,763 | 0.49 | 1.89 | 1.28 | 0.51 | 20.74638417 | 430.4124560 | 0.00 |
| 7 | 2001 | 1 | 110,597,900 | 0.47 | 1.97 | 1.47 | 0.50 | 18.52141042 | 343.0426440 | 0.00 |
| 7 | 2002 | 1 | 119,203,260 | 0.45 | 2.03 | 1.21 | 0.37 | 18.59634066 | 345.8238860 | 0.00 |
| 7 | 2003 | 1 | 119,192,200 | 0.46 | 1.70 | 1.18 | 0.57 | 18.59624787 | 345.8204350 | 0.00 |
| 7 | 2004 | 1 | 129,246,280 | 0.61 | 1.87 | 1.32 | 0.50 | 18.67723029 | 348.8389313 | 0.00 |
| 7 | 2005 | 1 | 152,397,450 | 0.56 | 1.95 | 1.55 | 0.49 | 18.84198278 | 355.0203152 | 0.00 |

XX

Annex 5:Data of Input and Output

| Firm | Year | Output PREMIUM | Output INVINCOM | Input LABOR | Input MATERIAL/CPI | Input FINCAP | Input DEBTCAP |
|---|---|---|---|---|---|---|---|
| 1 | 1996 | 205292000 | 15748915 | 1086 | 162173.40 | 66090371 | 196115533 |
| 1 | 1997 | 185918000 | 19046000 | 1113 | 178229.10 | 68165910 | 205753298 |
| 1 | 1998 | 172182000 | 18544500 | 1142 | 163125.63 | 72169826 | 207826365 |
| 1 | 1999 | 172212000 | 23539210 | 1059 | 210858.08 | 76225631 | 194720766 |
| 1 | 2000 | 185018000 | 23148800 | 1059 | 195870.82 | 76225631 | 190488912 |
| 1 | 2001 | 160116000 | 22288000 | 1078 | 220252.00 | 83609175 | 191235301 |
| 1 | 2002 | 169626000 | 22829000 | 1061 | 210603.59 | 83506818 | 189455585 |
| 1 | 2003 | 175039000 | 20602436 | 1110 | 209849.05 | 87496876 | 225130941 |
| 1 | 2004 | 189791000 | 25725000 | 1124 | 9155941.0 | 91372683 | 212478845 |
| 1 | 2005 | 193532000 | 20407530 | 1134 | 272361.00 | 96309494 | 214907169 |
| 2 | 1996 | 16716507 | 1653530 | 15 | 19621.30 | 9421656 | 22760302 |
| 2 | 1997 | 18380656 | 1975739 | 62 | 21683.41 | 11238564 | 27111788 |
| 2 | 1998 | 21512050 | 1957455 | 71 | 26316.65 | 14138252 | 28454138 |
| 2 | 1999 | 25204500 | 2072077 | 83 | 28591.13 | 21642068 | 35642930 |
| 2 | 2000 | 26237425 | 2484822 | 114 | 31844.96 | 25163459 | 36924330 |
| 2 | 2001 | 31446370 | 2484822 | 119 | 59037.25 | 24356628 | 43596170 |
| 2 | 2002 | 33581550 | 1928493 | 122 | 59037.25 | 27346440 | 50214865 |
| 2 | 2003 | 34760800 | 1846340 | 128 | 46970.58 | 29655417 | 53461678 |
| 2 | 2004 | 36473200 | 1846340 | 146 | 71649.80 | 29655417 | 55234080 |
| 2 | 2005 | 42220002 | 3022371 | 163 | 79294.64 | 30274779 | 59536082 |
| 3 | 1996 | 5427400 | 7654332 | 45 | 12263.91 | 15073580 | 4020160 |
| 3 | 1997 | 14412650 | 1243850 | 62 | 23570.43 | 15225561 | 10643043 |
| 3 | 1998 | 20949440 | 931675 | 82 | 33786.96 | 15549106 | 16019860 |
| 3 | 1999 | 36149729 | 1104983 | 91 | 36357.85 | 16135106 | 23016463 |
| 3 | 2000 | 36986590 | 1556921 | 98 | 39328.66 | 16773397 | 30770393 |
| 3 | 2001 | 36227450 | 1431059 | 108 | 47893.00 | 27685750 | 34003784 |
| 3 | 2002 | 37408740 | 2656740 | 119 | 51883.92 | 28220985 | 34679011 |

| Firm | Year | Output<br>PREMIUM | Output<br>INVINCOM | Input<br>LABOR | Input<br>MATERIAL/CPI | Input<br>FINCAP | Input<br>DEBTCAP |
|---|---|---|---|---|---|---|---|
| 3 | 2004 | 34298050 | 2531754 | 134 | 65442.87 | 30066919 | 21256849 |
| 3 | 2005 | 40831460 | 1124000 | 156 | 73453.5 | 30066913 | 20638691 |
| 4 | 1996 | 10849520 | 830203 | 28 | 19990.20 | 8661352 | 6817690 |
| 4 | 1997 | 17309930 | 930203 | 46 | 26352.77 | 13945507 | 10964190 |
| 4 | 1998 | 18567800 | 970406 | 58 | 34887.29 | 15824210 | 14130824 |
| 4 | 1999 | 29176800 | 930370 | 67 | 29274.53 | 14159099 | 15461020 |
| 4 | 2000 | 25715700 | 907046 | 78 | 39419.05 | 14589099 | 21927980 |
| 4 | 2001 | 30716500 | 2088585 | 92 | 53188.87 | 25857870 | 24553180 |
| 4 | 2002 | 36038740 | 1417911 | 104 | 60717.63 | 27685750 | 31176422 |
| 4 | 2003 | 35821010 | 1378911 | 115 | 57387.30 | 28685750 | 35811360 |
| 4 | 2004 | 31787236 | 1463370 | 127 | 75088.00 | 29706268 | 29036730 |
| 4 | 2005 | 28194769 | 3364635 | 131 | 66751.57 | 29655919 | 27004474 |
| 5 | 1996 | 10128945 | 126175 | 27 | 18540.71 | 3586157 | 7401214 |
| 5 | 1997 | 13679945 | 250418 | 42 | 24219.20 | 4056268 | 7601206 |
| 5 | 1998 | 12795739 | 260787 | 57 | 33702.34 | 5079960 | 7689188 |
| 5 | 1999 | 12061296 | 164510 | 69 | 35009.78 | 5269268 | 8959461 |
| 5 | 2000 | 11539979 | 160440 | 73 | 35900.17 | 5844618 | 8617414 |
| 5 | 2001 | 12858562 | 206501 | 81 | 40836.54 | 6444618 | 9296291 |
| 5 | 2002 | 13017896 | 462923 | 91 | 41926.79 | 6482683 | 10874719 |
| 5 | 2003 | 14517330 | 33423 | 99 | 41816.14 | 7103209 | 11874719 |
| 5 | 2004 | 16697524 | 639720 | 105 | 59633.55 | 8139933 | 14302580 |
| 5 | 2005 | 20980390 | 557220 | 108 | 53618.79 | 8572933 | 17021895 |
| 6 | 1996 | 3042350 | 208652 | 29 | 21222.53 | 20125000 | 3238872 |
| 6 | 1997 | 10595435 | 1181446 | 46 | 42368.09 | 25176293 | 9296386 |
| 6 | 1998 | 21784300 | 1628635 | 71 | 39233.67 | 25681599 | 16692270 |
| 6 | 1999 | 28056930 | 1854330 | 82 | 50468.38 | 26305940 | 27104793 |
| 6 | 2000 | 32426225 | 2190548 | 100 | 41686.21 | 27025200 | 35129351 |
| 6 | 2001 | 32742439 | 5793435 | 132 | 49692 | 27906738 | 38276529 |
| 6 | 2002 | 45735982 | 1935890 | 136 | 54056.97 | 28925020 | 35554020 |

| Firm | Year | Output | Output | Input | Input | Input | Input |
|---|---|---|---|---|---|---|---|
| | | PREMIUM | INVINCOM | LABOR | MATERIAL/CPI | FINCAP | DEBTCAP |
| 6 | 2004 | 42592505 | 2752941 | 169 | 57592.92 | 32997805 | 37799640 |
| 6 | 2005 | 44961910 | 5465337 | 179 | 70445.05 | 35904948 | 42381165 |
| 7 | 1996 | 14249128 | 1083605 | 21 | 18540.71 | 20829343 | 10147303 |
| 7 | 1997 | 29660564 | 232670 | 47 | 24219.2 | 23531431 | 19716459 |
| 7 | 1998 | 30842833 | 2494439 | 65 | 33702.34 | 26078164 | 24724738 |
| 7 | 1999 | 38003747 | 2445358 | 88 | 35009.78 | 31558164 | 32915463 |
| 7 | 2000 | 45570261 | 2394780 | 104 | 35900.17 | 35370375 | 40613741 |
| 7 | 2001 | 51366637 | 3868657 | 157 | 40836.54 | 36817084 | 47756139 |
| 7 | 2002 | 55098203 | 5361699 | 194 | 42880.98 | 37822099 | 65758898 |
| 7 | 2003 | 51210128 | 3402990 | 219 | 41926.79 | 38703552 | 49367482 |
| 7 | 2004 | 55661175 | 2230162 | 234 | 41816.14 | 41426561 | 59336629 |
| 7 | 2005 | 62903742 | 9035610 | 258 | 53618.79 | 42055208 | 65758898 |

Source: Various annual reports of insurance companies

N.B. firm1=EIC,firm2=Awash,firm3=Africa,firm4=United ,firm5=NICE,firm6=Nyala and firm7 Nile

# DECLARATION

I, the undersigned, declared that this thesis is my original work, and that all sources of materials used for the thesis have been duly acknowledged.

**Declared by:**

**Abdunasir Abdurahman Abubeker**

**Signature**

**Confirmed By:**

**Dr.Shail Singh**

**Signature**

**Place and Date of Submission**
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**July,2006**