“Assessment of measurement and ranking of technical efficiencies of Ethiopian general insurers”

AUTHORS
Kishor Meher [https://orcid.org/0000-0003-1294-7915
http://www.researcherid.com/rid/L-4260-2018
Abebe Asfawu [https://orcid.org/0000-0001-8120-335X
Maheswaran Muthuraman [https://orcid.org/0000-0001-5562-1021
Sanjay Kumar Satapathy [https://orcid.org/0000-0002-0467-4585

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Abstract

The non-life insurance companies indemnify the properties from the risk of being damaged due to unforeseen events like natural calamity or accidents. The probability of bankruptcy is imminent on account of large, unprecedented claims. As a risk saver of various society stakeholders, these insurers must be efficient while managing the insurance business. The present research thrusts upon to evaluate the efficiency and decomposition that would further direct the insurers towards achieving optimal scale. Thus, the captioned research aims to measure and rank the technical efficiency of the general insurance firms of Ethiopia and evaluate and analyze their relative efficiencies. The research adopts a quantitative approach and deploys descriptive analysis by a panel data of 17 Ethiopian general insurers for the period 2005-2016 on the input-output-oriented approach of Data Envelopment Analysis (DEA). The data of general insurance are obtained using stratified sampling from the mix of life and general category. The inputs employed are total expenses, total liabilities, and shareholder's fund, while net premiums earned and income from investments are used as outputs. The findings reveal that the public insurer is technically efficient by operating at an optimal scale as compared to all private insurers who, in turn, experience pure technical inefficiency to scale inefficiency due to poor management practices and erroneous utilization of input materials. Increasing Returns to Scale (IRS) witnessed a major form of scale inefficiency in 2016. Private insurers should increase capital and size of assets, cost efficiency, and improve key management skills.

Keywords
Data Envelopment Analysis (DEA), Pure Technical Efficiency (PTE), Scale Efficiency (SE), Variable Returns to Scale (VRS), Constant Returns to Scale (CRS), Increasing Returns to Scale (IRS)

JEL Classification
G22, L25, C33

INTRODUCTION

A country’s financial system comprises financial institutions, financial assets, and organized capital markets through a blend of financial services. The motto behind the financial system is to transform and channelize the spare capital from the hoarders to the scarcity sectors to balance capital distribution, thus fueling economic growth. The insurance sector is an integral chunk of the financial system and becomes an apparatus for the nations’ economic growth by indemnifying the individuals’ risks, assets, and corporates at large. Insurance plays a dynamic role among stakeholders such as investors, customers, policymakers, administrators, managers, governments, and after all, the communities to safeguard them from unforeseeable risk. The policymakers also expect the insurance companies to perform in the best interest of society’s social cause.

The insurance sector acts as a cushion to mitigate the perils of risks associated with people, the property of a country, the absence of which could derail economic growth. Because of huge insurance claims due
to frequent natural catastrophes in Ethiopia, the risk of bankruptcy of insurance companies is very high, necessitating the insurance companies to be efficient in enhancing return on investment. Further, the social obligation of the insurers is imminent for the welfare of society. Hence, management expects the organizations to be cost-efficient and profitable to accomplish social obligations while remaining technically efficient. The insurers should bear the risk burden by compensating adequately for the insured from the customers’ perspective. Feyen et al. (2011) noted the evidence of a causal relationship between insurance sector development and economic growth. Udaibir et al. (2003), cited in Meher and Zewudu (2020, p. 72), observed insurance as a source of financial system vulnerability. They further noted the insurance sector’s failure due to the “assimilation of banking activities, investing in risky assets like real estate and junked bonds, cross-shareholding with banks increases the risk of systemic vulnerability.”

The history of insurance in Ethiopia was initiated way back in 1905 during King Minilik II; the Bank of Abyssinia’s first insurance business started. During the regime of HaileSassie after Ethiopia became liberated from Italian occupation in 1941, many private insurance companies have become operational. From 1974, in pursuance of proclamation No. 261/1975, thirteen private insurance companies had been nationalized under the Federal Democratic Republic of Ethiopia (NBE, n.d.).

1. LITERATURE REVIEW

The following empirical studies confirm the relevance of insurance companies’ technical efficiency in the regional and global context.

Kumbhakar (1987) noted that in pursuance of the competition amongst the rival firms, the insurance firms wanted to maximize profits to remain technically efficient by adopting an output-oriented approach to DEA. A sample of Nigerian insurance firms has been taken for study from 1994 to 2005 and observed declining efficiency largely attributable to inadequate management strategy and scale inefficiency (Barros & Obijiaki, 2007). The panel data of 30 insurance companies of Ghana has been analyzed in DEA from 2006 to 2008 and concluded that the life insurance business’s technical efficiency score is better than the general insurance business (Ansah-Adu et al., 2013). The insurance companies in the Gulf Cooperation Council (GCC) region are moderately efficient, and there is enough scope for improvement (Al-Amri et al., 2012). Chinese insurance firms are studied with 22 insurers from 1999 to 2004 using DEA and found improved technical efficiency with these firms, especially big insurers, and are better efficient than small insurers (Yao et al., 2007). The performance of the standalone Life Insurance Company of India was examined for 19 years and showed the declining performance after 1994–1995 due to modernization incurring huge fixed costs but showing signs of improvement from 2000 to 2001 (Tone & Sahoo, 2005).

Sinha (2015) has studied a sample of 14 Indian life insurance companies using a dynamic DEA model and observed significant fluctuation of mean technical efficiency over the period of study.

The German property liability market has been analyzed thoroughly, with 148 insurance firms from 1995 to 2006 using DEA. The authors claimed that companies undertaking specialized insurance services are technically and cost-wise efficient than companies with various business verticals (Eling & Luhlen, 2010). Greek general insurance companies were studied from 1991 to 1996 and observed wide fluctuation inefficiency among the general insurers (Noulas et al., 2001). The Chinese insurance market was examined to estimate the efficiency of foreign and domestic life insurance firms. The authors argued that domestic insurance firms are efficient than foreign insurers due to dominance by the former. However, both the categories have experienced decreasing returns to scale (Chen et al., 2009). Bawa and Navjeet (2014) have taken 4 Indian public general insurers for 21 years consisting of pre- and post-reform period and found that these insurers were comparatively better in the pre-reform period as the percentage of wastages of resources was less in this period.
1.1. Problem statement

As a part of underwriting services, the insurers should demonstrate the momentum of proficiency for long-term sustainability while shielding from the menaces of bankruptcy in the episode of huge claims due to natural misfortunes. To meet such unforeseeable claims, the insurance companies also need to retain their efficiency in such cases by shifting their risk burden to the giant insurers through reinsurance. Due to the underwriting nature of service to the insured, insurance companies must be efficient, which becomes a relevant part of contemporary research in every country.

This research distinguishes from the former empirical literature in several ways and explores the existing literature. Firstly, the research has included selective output and input variables, which other researchers have not taken. Secondly, this study measures 17 Ethiopian insurance companies’ technical efficiency but limited to general insurance activities only keeping in mind the probability of most likely insurance claims due to frequent natural calamity as experience from the past. Further, it is common in Ethiopia that whenever a bank is formed, the insurance company will be formed simultaneously as a sister company as a form of bancassurance. It becomes vital for the later in fulfilling the social objectives and being profitable in the future. Numerous studies have been done in earlier times on financial performance in the Ethiopian context. Still, no study has been undertaken on measurement, ranking, and relative TE of general insurers in the Ethiopian context. This knowledge gap motivates the researcher to study Ethiopia’s general insurance to assess the measurement, ranking of technical efficiencies, and decomposition from 2005 to 2016 using an input-output-oriented approach through DEA.

1.2. Objectives of the study

- To identify various input and output variables that determine the technical efficiency of general insurance companies.
- To evaluate the technical efficiency and ranking of insurance companies.
- To study the year-wise decomposition of all insurance companies’ technical efficiency and firm-wise decomposition for 2016.

2. METHODS

This study of general insurance companies’ technical efficiency adopts a quantitative research approach followed by descriptive analysis (Creswell, 2009). All the insurance companies registered under the National Bank of Ethiopia (NBE) constitute a study (NBE, n.d.). Seventeen insurance companies are registered at the National Bank of Ethiopia, consisting of one public and sixteen privately-owned companies. Stratified sampling has been deployed to obtain a sample of only general insurance companies from the composite activities of life and general insurance business. Panel data of 17 insurance companies from 2005 to 2016 have been taken since their inception undertaking the general insurance business (see Appendix A). The secondary data have been sourced from the reports of the financial statements of the insurers.

Evaluating financial institutions’ efficiency is done by a parametric approach called Stochastic Frontier and a non-parametric approach called Data Envelopment Analysis (DEA). DEA is deployed to analyze the efficiencies of financial institutions. The DEA is vividly presented by Lovell (1993), Charnes et al. (1995), Seiford (1996), Seiford and Thrall (1990), Ali and Seiford (1993). DEA applies linear programming through multiple inputs and output data to find the relative ranking of institutions under the same industry, whereas SFA examines the institutions’ absolute economic efficiency (Berger & Humphrey, 1992; Coelli et al., 1998; Coelli, 1996). However, Bauer et al. (1998) have found that both methods complement the efficiency and generally give similar results.

Since the insurance companies in Ethiopia provide various financial services as part of the people’s social obligation and economic well-being, it complicates the deployment of a parametric way to test TE. Thus, the input approach DEA is preferred since the insurance companies’ managers have more preference to optimize the outputs by lessening the input resources or with an agreed input.

This study has been analyzed in two stages. Charnes et al. (1978) has developed the Data Envelopment Analysis Program (DEAP) called CCR model, where initially, the scores of efficiency of 17 insurance companies taken as Decision-Making Units (DMU) are calculated and analyzed.

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Secondly, Gollani and Roll (1989) noted the overall efficiency of each DMU into Pure Technical Efficiency (PTE) and Scale Efficiency (SE) by CCR model assuming Constant Returns to Scale (CRS). Further, efficiency scores have been calculated and analyzed through Variable Returns to Scale (VRS) developed by Banker et al. (1984) called BCC model to estimate Pure Technical Efficiency only.

2.1. Model specification

This study has been designed to implement the CRS and VRS model outlined by Fare et al. (1994) to evaluate technical efficiency and scale efficiency.

The model specification of Constant Returns to Scale (CRS) is given for each Decision-Making Unit (DMU) to measure the technical efficiency measured as the ratio of all outputs over all inputs is obtained. The optimal weight of each DMU is described as follows:

\[
\begin{align*}
\max_{\lambda} & \left( u^\top \frac{y}{v} x \right), \\
\text{s.t.} & \quad u^\top \frac{y}{v} x \leq 1, \quad \text{where} \quad I = 1, 2, 3, \ldots, N, \\
& \quad u, v \geq 0,
\end{align*}
\]

where, \( u \) is the \( MXI \) vector of output weights, \( v \) is the \( KXI \) vector of input weights.

The model specification for VRS is given as ‘the CRS linear programming problem can be easily modified to account for VRS by adding the convexity constraint’ (Dutta & Sengupta, 2011, p. 420).

\[
\begin{align*}
\min_{\theta, \lambda} & \theta, \\
\text{s.t.} & \quad y + Y \lambda \geq 0, \\
& \quad x^\top \lambda \geq 0, \\
& \quad N^\top \lambda = 1, \\
& \quad \lambda \geq 0,
\end{align*}
\]

where \( N^1 \) is an \( N \times 1 \) vector of ones.

When all the 17 insurance companies are operating at an optimal scale, then CRS is deemed appropriate. However, this is not practical due to imperfect competition and inadequate finance. In such cases, Banker et al. (1984) argued for VRS to evaluate technical efficiency devoid of scale efficiency. This view is supported by Coelli (1996).

The technical efficiency of all the insurance firms has been divided into Overall Technical Efficiency, Pure Technical Efficiency, and Scale Efficiency. The Overall Technical Efficiency (OTE) indicates the number of inputs that could be reduced without affecting the insurance companies’ output levels. An organization is technically efficient if it produces output with a given input (Marwa & Aziakpono, 2016).

Pure Technical Efficiency is defined as the additional consumption of the input resources for a specified output due to operational efficiency. Additionally, it is the management’s skill to save the input from producing a certain output or producing more output with a given input. Pure Technical Efficiency (PTE) indicates the extent of overall inefficiency caused by managerial inefficiency or wastage of resources without scale effect. Pure Technical Efficiency of the insurance companies is measured using the BCC model. Farell (1957), Kounetas and Tsekouras (2007) defined Scale Efficiency as the extent of productivity a firm could achieve to reach optimal scale size. This is the point of time that average productivity will be at its peak level. Scale Efficiency (SE) measures the extent of overall inefficiency caused due to the wrong choice of scale of the insurance company’s operation. The insurance firms’ Scale Efficiency is calculated by dividing the efficiency scores as per the CCR model with technical efficiency using the VRS model.

The study subdivides the variables of inputs into three main categories: business services and materials, capital, and labor. It is considered necessary to improve the scheme of input choice by mixing labor and business services and materials in operating expenses. This improvement is made in efficiency studies of the insurance sector observed (Diacon et al., 2002; Eling & Luhnen, 2010). Furthermore, many research works have considered equity capital a relevant input (Cummins & Weiss, 2000; Eling & Luhnen, 2010). Finally, debt capital is utilized as an input in numerous insurance studies (Leverty & Grace, 2010). Thus, entire liabilities, full expenses, and shareholder funds act as inputs for this research.

The outputs are the intermediation approach, the user cost method, and the value-added approach.
in insurance firms (Brocket et al., 1998). The user cost approach is based on financial products as input or output based on its net contribution to its revenue, which looks theoretically sound but practically difficult (Cummins & Weiss, 2000).

The value-added approach specifies three main services offered by insurers as outputs: risk pooling/bearing services, intermediation, and financial services related to incurred losses. The insurance policy premium is the common proxy of indemnifying the insured (Cummins & Weiss, 2000). Investment income is a good proxy for the intermediation function and is often utilized in the literature (Cummins & Santomero, 1999; Berger et al., 2008). The common output variables are premiums income and investment income in numerous insurance efficiency studies (Saad, 2012; Abduh et al., 2012; Eling & Luhnen, 2010).

Thus, income from investment and premiums earned is taken as the output for this research. The elements of the resources of input and output are stated in Appendix B.

### 3. RESULTS AND DISCUSSION

The descriptive analysis of input and outputs has been analyzed as per Table 1.

Table 1 reveals that based on the minimum, the maximum, mean, and standard deviation of variables of outputs; there is a wide variation observed of investment income and net premium earned amongst the general insurers. A similar trend has been observed for input variables, such as total expenses, total liabilities, and total shareholder’s fund during the period under study.

The technical efficiency and ranking of general insurance companies are analyzed under CCR model (Charnes et al., 1978) and BCC model (Banker et al., 1984).

#### 3.1. Efficiency results under the Constant Returns to Scale (CCR model)

The defined variables of input and yield are entered into DEA under the CCR model to compute all general insurance companies’ technical efficiency.

| Year | No of DMUs | Number of efficient companies | Maximum efficiency score | Minimum efficiency score | SD | Mean of efficiency | Mean of inefficiency (1−M)/M | % of the DMUs in 1 |
|------|------------|-------------------------------|--------------------------|--------------------------|----|--------------------|----------------------------|-------------------|
| 2005 | 9          | 4                             | 1                        | 0.51                     | 0.19| 0.83               | 0.20                       | 0.44              |
| 2006 | 9          | 4                             | 1                        | 0.79                     | 0.09| 0.91               | 0.10                       | 0.44              |
| 2007 | 9          | 4                             | 1                        | 0.55                     | 0.18| 0.84               | 0.19                       | 0.44              |
| 2008 | 9          | 6                             | 1                        | 0.46                     | 0.18| 0.93               | 0.08                       | 0.67              |
| 2009 | 10         | 4                             | 1                        | 0.61                     | 0.13| 0.90               | 0.11                       | 0.40              |
| 2010 | 10         | 7                             | 1                        | 0.62                     | 0.13| 0.94               | 0.06                       | 0.70              |
| 2011 | 11         | 5                             | 1                        | 0.66                     | 0.13| 0.89               | 0.12                       | 0.45              |
| 2012 | 11         | 7                             | 1                        | 0.81                     | 0.06| 0.98               | 0.02                       | 0.64              |
| 2013 | 15         | 7                             | 1                        | 0.21                     | 0.11| 0.94               | 0.06                       | 0.47              |
| 2014 | 16         | 5                             | 1                        | 0.52                     | 0.17| 0.83               | 0.20                       | 0.31              |
| 2015 | 17         | 3                             | 1                        | 0.28                     | 0.22| 0.71               | 0.41                       | 0.18              |
| 2016 | 17         | 2                             | 1                        | 0.44                     | 0.19| 0.72               | 0.39                       | 0.12              |
| Mean | 12         | 5                             | 1                        | 0.54                     | 0.21| 0.84               | 0.16                       | 0.29              |
The results in Table 2 show that the average technical efficiency of the insurance companies ranges from a minimum of 0.71 (71%) in 2015 to a maximum of 0.98 (98%) in 2012, with an average efficiency of 0.84 (84%). This implies that the Ethiopian insurance companies have scope to increase their mean technical efficiency by 16% (1 - 0.84) in maximizing their output without adding any additional resources or at a certain level of inputs. Besides that, the mean, standard deviation of 0.21 (21%) specifies a moderate dispersion of the general insurance firms' technical efficiencies during the period under review.

Table 3. Company-wise rank and relative efficiency of the insurance companies under the Constant Returns to Scale (CCR model)

| S.N. | DMUs  | 2005  | 2006  | 2007  | 2008  | 2009  | 2010  | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | Mean Rank |
|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----------|
| 1    | EIC   | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1          |
| 2    | Awash | 0.64  | 0.79  | 0.69  | 0.95  | 0.93  | 1.00  | 0.77  | 0.94  | 0.97  | 0.95  | 0.56  | 0.85  | 8          |
| 3    | Global| 0.51  | 1.00  | 1.00  | 0.46  | 0.6   | 0.62  | 0.78  | 0.81  | 1.00  | 0.83  | 1.00  | 0.80  | 10         |
| 4    | Nile  | 1.00  | 1.00  | 1.00  | 1.00  | 0.88  | 1.00  | 1.00  | 1.00  | 1.00  | 0.79  | 0.71  | 0.95  | 2          |
| 5    | Nice  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 0.96  | 0.84  | 0.63  | 0.62  | 0.92  | 4          |
| 6    | Africa| 0.78  | 0.71  | 0.81  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 0.94  | 3          |
| 7    | Nib   | 0.64  | 0.80  | 0.58  | 0.98  | 0.78  | 0.80  | 0.66  | 0.97  | 0.70  | 0.79  | 0.71  | 0.88  | 0.74  | 12         |
| 8    | Nyla  | 0.90  | 0.89  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 0.57  | 1.00  | 0.70  | 0.92  | 16         |
| 9    | Unic  | 1.00  | 1.00  | 1.00  | 1.00  | 0.97  | 1.00  | 0.92  | 0.98  | 0.74  | 0.87  | 0.56  | 0.60  | 0.89  | 7          |
| 10   | Lion  |       |       |       |       |       |       |       |       |       |       |       |       |            |
| 11   | Oromia|       |       |       |       |       |       |       |       |       |       |       |       |            |
| 12   | Abay  |       |       |       |       |       |       |       |       |       |       |       |       |            |
| 13   | Berhan|       |       |       |       |       |       |       |       |       |       |       |       |            |
| 14   | Tsehay|       |       |       |       |       |       |       |       |       |       |       |       |            |
| 15   | Ethio |       |       |       |       |       |       |       |       |       |       |       |       |            |
| 16   | Lucy  |       |       |       |       |       |       |       |       |       |       |       |       |            |
| 17   | Bunna |       |       |       |       |       |       |       |       |       |       |       |       |            |

The relative technical efficiency company-wise and their ranks from highest to lowest based on the mean score are described in Table 3.

Table 3 shows that EIC (1st rank) is the most competitive insurance firm in all the twelve consecutive years, having an efficiency score of 1 (100%), followed by Nile (2nd rank) and Africa (3rd rank) with an average technical efficiency 0.95 (95%) and 0.94 (94%), respectively. On the other hand, Lucy (17th rank) is the least competent insurance firm observed with an average TE of 0.34 (34%), followed by Bunna (16th rank) with 0.38 (38%).

Source: Annual report of GICs computed by DEAP version 2.1.

Figure 1. Relative technical efficiency score under CCR model
Figure 1 reveals the frequency distribution of the relative technical efficiency of the insurance firms. The average relative technical efficiency is 35.24% in the range above 90%, followed by 53% in the range from 50% to 90%, and lastly, 11.76% in the range below 50%. This implies that technical efficiency scores are tilted towards higher efficiency in 6 insurance companies above 90% range and moderate efficiencies in 9 insurance companies between 50% to 90% range trailed by 2 insurance companies below 50% range.

The efficiency of general insurance companies has been computed under Variable Returns to Scale (VRS) under BCC model shown further.

3.2. Efficiency results under the VRS (BCC model)

Table 4 shows that the average TE of the general insurers ranges from a minimum of 0.84 (84%) in the years 2005, 2007, and 2013 to a maximum of 0.98 (98%) in 2012 with an overall mean efficiency of 0.89 (89%). It means the insurance companies have scope to increase their average TE by 11% (1-0.89) by maximizing their output without adding any added resources or a given level of inputs. The average SD of 0.09 (9%) displays a low dispersion of TE of the insurance companies.

### Table 4. Technical efficiency of insurance companies under the VRS (BCC model)

| Year | No of DMUs | Number of efficient companies | Maximum efficiency score | Minimum efficiency score | SD | Average of efficiency M | % of the DMUs in 1 |
|------|------------|-------------------------------|--------------------------|--------------------------|----|------------------------|------------------|
| 2005 | 9          | 4                             | 1                        | 0.51                     | 0.20 | 0.84                   | 0.44             |
| 2006 | 9          | 4                             | 1                        | 0.79                     | 0.21 | 0.93                   | 0.44             |
| 2007 | 9          | 4                             | 1                        | 0.55                     | 0.20 | 0.84                   | 0.44             |
| 2008 | 9          | 6                             | 1                        | 0.46                     | 0.18 | 0.94                   | 0.67             |
| 2009 | 10         | 4                             | 1                        | 0.61                     | 0.13 | 0.90                   | 0.40             |
| 2010 | 10         | 7                             | 1                        | 0.62                     | 0.13 | 0.94                   | 0.70             |
| 2011 | 11         | 5                             | 1                        | 0.66                     | 0.13 | 0.90                   | 0.45             |
| 2012 | 11         | 7                             | 1                        | 0.81                     | 0.06 | 0.98                   | 0.64             |
| 2013 | 15         | 7                             | 1                        | 0.21                     | 0.26 | 0.84                   | 0.47             |
| 2014 | 16         | 5                             | 1                        | 0.52                     | 0.16 | 0.85                   | 0.31             |
| 2015 | 17         | 3                             | 1                        | 0.56                     | 0.15 | 0.87                   | 0.18             |
| 2016 | 17         | 2                             | 1                        | 0.62                     | 0.13 | 0.90                   | 0.12             |
| Mean | 12         | 5                             | 1                        | 0.71                     | 0.09 | 0.89                   | 0.29             |

**Table 5. Company-wise rank and relative efficiencies of the insurance companies under VRS (BCC model)**

Source: Annual report of GICs computed by DEAP version 2.1.

| S.N. | DMUs | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Mean | Rank |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1    | EIC  | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1 |
| 2    | Awash| 0.64 | 0.79 | 0.69 | 0.98 | 0.94 | 1.00 | 0.80 | 1.00 | 0.97 | 1.00 | 0.96 | 0.68 | 0.87 | 11 |
| 3    | Global | 0.51 | 1.00 | 0.55 | 0.46 | 0.61 | 0.62 | 0.78 | 0.81 | 1.00 | 0.83 | 1.00 | 1.00 | 0.76 | 15 |
| 4    | Nile | 1.00 | 1.00 | 1.00 | 1.00 | 0.88 | 1.00 | 1.00 | 1.00 | 1.00 | 0.91 | 0.75 | 0.96 | 3 |
| 5    | Nice | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.96 | 0.84 | 0.71 | 1.00 | 0.95 | 2 |
| 6    | Africa | 0.78 | 0.82 | 0.71 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.91 | 0.75 | 0.96 | 3 |
| 7    | Nib | 0.64 | 0.80 | 0.58 | 0.98 | 0.78 | 0.80 | 0.66 | 1.00 | 0.70 | 0.89 | 0.75 | 0.90 | 0.79 | 13 |
| 8    | Nya | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.97 | 1.00 | 0.57 | 1.00 | 0.76 | 0.94 | 5 |
| 9    | Unic | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.99 | 1.00 | 0.74 | 0.87 | 0.56 | 0.62 | 0.90 | 8 |
| 10   | Lion | –    | –    | –    | 0.85 | 1.00 | 0.77 | 1.00 | 1.00 | 0.84 | 0.65 | 1.00 | 0.89 | 10 |
| 11   | Oromia | –    | –    | –    | –    | 1.00 | 1.00 | 0.91 | 0.88 | 0.94 | 0.95 | 0.4 |
| 12   | Abay | –    | –    | –    | 0.46 | 0.61 | 0.62 | –    | –    | 0.75 | 0.62 | 0.71 | 0.91 | 0.75 | 16 |
| 13   | Berhan | –    | –    | –    | –    | 0.86 | 0.74 | 1.00 | 1.00 | 0.90 | 8 |
| 14   | Tsehay | –    | –    | –    | –    | 0.61 | 1.00 | 0.85 | 0.98 | 0.86 | 12 |
| 15   | Ethio | –    | –    | –    | –    | 0.32 | 0.52 | 1.00 | 1.00 | 0.71 | 17 |
| 16   | Lucy | –    | –    | –    | –    | –    | 0.21 | 1.00 | 0.86 | 1.00 | 0.77 | 14 |
| 17   | Bunna | –    | –    | –    | –    | –    | –    | 1.00 | 0.81 | 0.91 | 7 |
The rank and relative efficiency of the general insurance companies under Variable Returns to Scale (VRS) under the BCC model are computed and shown in Table 5.

The Variable Returns to Scale (VRS) as per Table 5 demonstrates that EIC (1st rank) is the most competitive insurance firm with a technical efficiency score of 1 (100%), followed by Nice (2nd rank) and Nile (3rd rank) with an average technical efficiency score of 0.961 (96.1%) and 0.959 (95.9%), respectively. In other words, Ethio (17th rank) was the least efficient insurance company with an average technical efficiency of 0.71 (71%), followed by Abay (16th rank) and Global (15th rank) with an average technical efficiency score of 0.75 (75%) and 76% (0.76), respectively, amongst all the general insurers.

Figure 2 reveals the frequency distribution of relative technical efficiency scores under the Ethiopian general insurance companies’ BCC model. The average technical efficiency score of 9 insurance companies is skewed towards 53% in the range above 90%, followed by 8 insurance companies by 47% in the range from 50% to 90%. Further, no average TE of insurance companies is observed in the range below 50%.

3.3. Comparison of relative technical efficiency under CCR and BCC model

The comparison of efficiency scores under CRS and VRS is discussed further to understand the insurers’ ranking. Bunna is the least efficient company (38%) under CRS, whereas it has become the most efficient company (81%) under VRS. This infers that the inefficiency caused at Bunna is because of inappropriate size from scale inefficiency rather than management practice. Further, it is observed that the distribution of relative TE score of 89% (0.89) under the VRS (BCC model) is forward-looking and better than the efficiency scores 84% (0.84) under CRS (CCR model).

3.4. Decomposition of technical efficiency

To ascertain the main source of general insurance companies’ inefficiency, the year-wise technical efficiency has been decomposed into OTE, PTE, and SE and described in Table 6.

The average TE of the whole insurance companies over the study period is 84 percent. The PTE is 89 percent and SE 95 percent on average (see Appendix C). Table 6 reveals that the average pure technical inefficiency accounts for 11% (1-0.89) compared to the average scale inefficiency as 5% (1-0.95). This implies that the technical inefficiency is large because of the pure technical inefficiency. Additionally, the relatively greater pure technical inefficiency proposes that inefficiency is caused mostly due to inadequate management practices or improper utilization of input resources rather than the inappropriate size of the general insurers emanating from scale inefficiency.
The comparison amongst the average TE, PTE, and SE is described in Figure 3. The figure portrays the highest scores of Scale Efficiency (SE) of the general insurers compared to efficiency scores under CRS (CCR model) and VRS (BCC model) in all the years except 2015 and 2016. This implies that the general insurance firms have enormous growth in size by increasing the branches from 2005 to 2014. This has resulted in increased Pure Technical Efficiency (PTE) during 2015 and 2016.

### 3.5. Decomposition of firm-wise technical efficiency for 2016

Further, concerning Returns to Scale (RTS), a study has been conducted for 2016 to understand the Scale Efficiency for the general insurance companies as some companies have started just before 2016. Table 7 shows all general insurance companies’ decomposition into overall TE, pure TE, SE, and increasing, decreasing, and constant returns to scales in 2016. As far as Scale Efficiency is concerned, 18% of total insurance companies, namely EIC, Global, and Africa, are scale efficient, having a relative Scale Efficiency score of 100% (1.00). The rest of the insurance firms constituting 82% have Scale Efficiency of below optimal scale means less than 100% (1), out of which 11 general insurance companies constituting 65% are operating at IRS, signifying that these general insurers can increase their technical efficiency by increasing their size of the operation. The remaining general insurers

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**Table 6. Decomposition of year-wise Overall Technical Efficiency (OTE), Pure Technical Efficiency (PTE), and Scale Efficiency (SE)**

| Year | OTE under CRS scale | PTE under VRS scale | SE = OTE/PTE |
|------|---------------------|---------------------|--------------|
| 2005 | 0.83                | 0.84                | 0.99         |
| 2006 | 0.91                | 0.93                | 0.98         |
| 2007 | 0.84                | 0.84                | 1.00         |
| 2008 | 0.93                | 0.94                | 0.99         |
| 2009 | 0.9                 | 0.9                 | 1.00         |
| 2010 | 0.94                | 0.94                | 1.00         |
| 2011 | 0.89                | 0.9                 | 1.00         |
| 2012 | 0.98                | 0.98                | 1.00         |
| 2013 | 0.94                | 0.84                | 1.00         |
| 2014 | 0.83                | 0.85                | 0.98         |
| 2015 | 0.71                | 0.87                | 0.82         |
| 2016 | 0.72                | 0.9                 | 0.80         |
| Average efficiency | 0.84 | 0.89 | 0.95 |
| Average inefficiency | – | 0.11 | 0.05 |

Source: Annual report of GICs computation through DEAP version 2.1.
constituting 17% are operating at DRS, implying that they can increase their technical efficiency by decreasing their operation size. Thus it is evident that the IRS is the predominant form of scale inefficiency seen with these companies for 2016. However, an opposite finding had been revealed by Owusu-Ansah et al. (2010) who observed that a good number of Ghanaian insurance companies were operating with professionally high managerial skills.

### CONCLUSION

The study’s findings demonstrate that all the insurance companies doing general insurance business activities suffer technical inefficiency by 16% under CRS and 11% under VRS. The government-run Ethiopian insurance company has achieved an optimal scale during the study period compared to the private insurers operating below optimal scale. Hence, the private general insurers can achieve optimal scale either through professional management practice and proper utilization of resources or by growing the general insurance business’s size by penetrating the market. This result is consistent with Kao and Hwang (2008) who observed that none of his study’s general insurers were found to achieve full efficiency.

The pure technical inefficiency of insurance companies is predominant over the scale inefficiency from 2005 to 2016, which implies that by and large, the general insurance companies should emphasize operations through effective deployment of resources if they want to achieve optimal scale. The scale economies for the year 2016 for all insurance companies reveal the prominence of IRS over DRS, which indicates that the insurance companies can enhance their technical efficiency by increasing the size operation of the general insurance business in Ethiopia. Thus, the measurement, ranking, relative TE, and decomposition into pure TE and SE, coupled with IRS, VRS, and CRS of general insurers, have met the study’s objectives. However, the research has the following limitations. The software used to evaluate TE does not support the data having negative numbers. The study focuses on the general insurance business but fails to measure the TE of the life insurance business run by some insurance companies having a composite business. Newly started insurance companies take time to demonstrate efficiencies, so they are not free from such bias. The insurance risk and efficiency could not be tested here and hence left scope for further researchers. The study hangs around the outcome of technical efficiency, which is

### Table 7. Decomposition of firm-wise technical efficiency for 2016

| No. | DMU       | OTE | PTE    | SE     | RTS |
|-----|-----------|-----|--------|--------|-----|
| 1   | EIC       | 1.00| 1.00   | 1.00   | CRS |
| 2   | Awash     | 0.56| 0.68   | 0.83   | IRS |
| 3   | Global    | 1.00| 1.00   | 1.00   | CRS |
| 4   | Nile      | 0.71| 0.75   | 0.95   | IRS |
| 5   | Nice      | 0.62| 1.00   | 0.62   | IRS |
| 6   | Africa    | 1.00| 1.00   | 1.00   | CRS |
| 7   | Nib       | 0.88| 0.90   | 0.98   | DRS |
| 8   | Nyala     | 0.70| 0.76   | 0.91   | IRS |
| 9   | Unic      | 0.6  | 0.62   | 0.98   | DRS |
| 10  | Lion      | 0.78| 1.00   | 0.78   | IRS |
| 11  | Oromia    | 0.84| 0.94   | 0.89   | IRS |
| 12  | Abay      | 0.9  | 0.91   | 0.99   | DRS |
| 13  | Berhan    | 0.53| 1.00   | 0.53   | IRS |
| 14  | Tsehay    | 0.46| 0.98   | 0.46   | IRS |
| 15  | ELIG      | 0.63| 1.00   | 0.63   | IRS |
| 16  | Lucy      | 0.6  | 1.00   | 0.60   | IRS |
| 17  | Bunna     | 0.44| 0.81   | 0.54   | IRS |
|     | Average   | 0.71| 0.90   | 0.79   | IRS |

Source: Annual report of GICs computed by DEAP version 2.1.
relevant for current operation by the manager by constantly striving for efficiency in a competitive market but fails to focus on the financial sustainability of insurance companies as advocated by Meher and Getanah (2019) on the financial sustainability of commercial banks of Ethiopia. This implies that managers focus on achieving a short-term goal to remain technically efficient by sacrificing the long-range goal of financial sustainability. The outcome of the study recommends that to reach an optimal scale. The private insurers should work towards enhancing capital by infusing adequate equity and also a debt to garner the benefit of leverage, increase the size of assets by expanding the business to reap the benefit of economies of scale, ponder on cost efficiency and improve the skills on key strategy, investment and financing decision-making. This result aims at future policy initiatives and found to be consistent with Dutta and Sengupta (2011) who observed that efficiency was the basic concern of policymakers to encourage further development of the insurance industry and the managers to be profitable in the insurance business. The study suffers from the limitation of recent data as data availability is up to the year 2016. The research is pertinent from the community’s points of view as the insurers being the risk savers of society. This study has thrown light on the perception of various stakeholders about the well-being of the insurance business and their credibility, creating a way to meet their expectations.

AUTHOR CONTRIBUTIONS

Conceptualization: Kishor Meher.  
Data curation: Abebe Asfawu, Maheswaran Muthuraman.  
Formal analysis: Kishor Meher, Maheswaran Muthuraman.  
Funding acquisition: Abebe Asfawu, Maheswaran Muthuraman, Sanjay Kumar Satapathy.  
Investigation: Abebe Asfawu.  
Methodology: Abebe Asfawu.  
Project administration: Kishor Meher.  
Resources: Abebe Asfawu, Maheswaran Muthuraman.  
Software: Kishor Meher.  
Supervision: Kishor Meher, Sanjay Kumar Satapathy.  
Validation: Maheswaran Muthuraman, Sanjay Kumar Satapathy.  
Visualization: Maheswaran Muthuraman, Sanjay Kumar Satapathy.  
Writing – original draft: Abebe Asfawu.  
Writing – review & editing: Kishor Meher.

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REFERENCES

1. Abduh, M., Omar, M., & Tarmizi, R. (2012). The Performance of the insurance industry in Malaysia: Islamic vis-a-vis conventional insurance. *Journal of Islamic Banking and Finance*, 29(4), 40-49. Retrieved from [http://irep.iium.edu.my/29018/](http://irep.iium.edu.my/29018/)

2. Al-Amri, K., Gattoufi, S., & Al-Muharrami, S. (2012). Analyzing the technical efficiency of insurance companies in GCC. *The Journal of Risk Finance*, 13(4), 362-380. [https://doi.org/10.1108/15265941211254471](https://doi.org/10.1108/15265941211254471)

3. Ali, A. I., & Seiford, L. M. (1993). The Mathematical Programming Approach to Efficiency Analysis. In H. O. Fried & S. S. Schmidt (Eds.), *The Measurement of Productive Efficiency: Techniques and Applications* (pp. 120-159). New York: Oxford University Press.

4. Ansah-Adu, K., Andoh, C., & Abor, J. (2013). Evaluating the cost efficiency of insurance companies in Ghana. *The Journal of Risk Finance*, 13(1), 61-76. [https://doi.org/10.1108/15265941211191949](https://doi.org/10.1108/15265941211191949)
5. Banker, R. D., Charnes, A., & Cooper, W. (1984). Some models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. Management Science, 30(9), 1078-1092. https://doi.org/10.1287/ msnsc.30.9.1078

6. Barros, C. P., & Obijiaki, E. L. (2008). Efficient Production and Risk Management in the Nigerian Insurance Industry. Omega, 36(2), 177-187. https://doi.org/10.1016/j.omega.2007.01.008

7. Bauer, P., Berger, A., Ferrier, G., & Humphrey, D. B. (1998). Consistency Conditions for Regulatory Analysis of Financial Institutions: A Comparison of Frontier Efficiency Methods. Journal of Economics and Business, 50(2), 85-114. https://doi.org/10.1016/S0148-6195(97)00072-6

8. Bawa, S. K., & Naveen, K. (2014). An Analysis of Efficiency-Profitability Relationship: A Study of Indian Public General Insurers. Paradigm, 18(1), 51-72. Retrieved from https://journals.sagepub.com/doi/abs/10.1177/0971890714540366

9. Berger, A. N., & Humphrey, D. B. (1992). Measurement and efficiency issues in commercial banking. In Z. Griliches (Ed.), Output Measurement in the Service Sectors (pp. 245-300). University of Chicago Press. Retrieved from http://www.nber.org/chapters/c7237

10. Berger, A., & Mester, L. (2008). Inside the Black Box: What Explains Differences in the Efficiencies of Financial Institutions? Journal of Banking & Finance, 21(7), 895-947. https://doi.org/10.1016/S0378-4266(97)00010-1

11. Brockett, P. L., Cooper, W. W., Golden, L. L., Rousseau, J. J., & Wang, Y. (1998). Evaluating solvency versus efficiency performance and different forms of organization and marketing in US property-liability insurance companies. European Journal of Operation Research, 154(2), 492-514. https://doi.org/10.1016/S0377-2217(03)00184-X

12. Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the Efficiency of Decision-Making Units. European Journal of Operational Research, 2(6), 429-444. https://doi.org/10.1016/0377-2217(78)90138-8

13. Charnes, A., Cooper, W. W., Lewin, A. Y., & Seiford, L. M. (1995). Data Envelopment Analysis: Theory, Methodology, and Applications. Boston, MA: Kluwer Academic Publishers. Retrieved from https://www.springer.com/gp/book/9780792394792

14. Chen, B., Powers, M. R., & Qiu, J. (2009). Life-insurance efficiency in China: a comparison of foreign and domestic firms. China & World Economy, 17(6), 43-63. https://doi.org/10.1111/j.1749-124X.2009.01173.x

15. Coelli, T. J. (1996). A Guide to DEA: Version 2.1: A Data Envelopment Analysis (Computer) Program (CEPA Working Paper No. 96/08). Centre for Efficiency and Productivity Analysis. Retrieved from http://www.cwlee.net. rice.edu/~econ380/DEAPPDF

16. Coelli, T. J., Rao, P., & Battese, G. E. (1998). An Introduction to Efficiency and Productivity Analysis. New York: Springer Science.

17. Creswell, W. (2009). Research design: quantitative, qualitative, and mixed methods approach (3rd ed.). Sage Publications, California.

18. Cummins, J. D., & Santomero, A. (1999). Changes in the Life Insurance Industry: Efficiency, Technology, and Risk Management. Kluwer Academic Publishers, Boston.

19. Cummins, J. D., & Weiss, M. A. (2000). Analyzing Firm Performance in the Insurance Industry Using Frontier Efficiency and Productivity Methods. In G. Dionne (Ed.), Handbook of Insurance Economics (pp. 767-829). Boston: Kluwer Academic Publishers. https://doi. org/10.1007/978-0-940-010642-2_24

20. Diacon, S. R., Starkey, K., & O’Brien, C. (2002). Size and efficiency in European long-term insurance companies: an international comparison. Geneva Papers on Risk and Insurance, 27(3), 444-466. Retrieved from https://econpapers.repec.org/articlepalgprr27_3ay_3a20 02_3ai_3a3_3ap_3a444-466.htm

21. Dutta, A., & Sengupta, P. P. (2011). Efficiency Measurement of Indian Life Insurance Industry in Post-Reforms Era. Global Business Review, 12(3), 415-430. https://doi. org/10.1177/097215091101200305

22. Eling, M., & Luhnen, M. (2010). Efficiency in the International Insurance Industry: A Cross-Country Comparison. Journal of Banking and Finance, 34(7), 1497-1509. https://doi.org/10.1016/j.jbankfin.2009.08.026

23. Fare, R., Grosskopf, S., & Lovell, C. A. K. (1994). Production Frontier. Cambridge University Press. https://doi.org/10.1017/CBO9780511551710

24. Farrell, M. J. (1957). The measurement of productive efficiency. Journal of the Royal Statistical Society, 120(3), 253-290. https://doi.org/10.2307/2345100

25. Feyen, E., Lester, R., & Rocha, R. (2011). What drives the development of the insurance sector? An empirical analysis based on a panel of developed and developing countries (Policy Research Working Papers). http://dx.doi.org/10.1596/1813-9450-3572

26. Gollani, B., & Roll, Y. (1989). An application procedure for DEA. Omega International Journal of Management Sciences, 17(3), 237-50. Retrieved from https://www. academia.edu/3603468/1989_An_application_procedure_for_DEA

27. Kao, C., & Hwang, S. N. (2008). Efficiency decomposition in two-stage data envelopment analysis: An application to non-life insurance companies in Taiwan. European Journal of Operational Research, 185(1), 418-429. https://doi.org/10.1016/j.ejor.2006.11.041

http://dx.doi.org/10.2151/ppm.18(4).2020.27
28. Kounetas, K., & Tsekouras, K. (2007). Measuring scale efficiency change using a Translog distance function. *International Journal of Business and Economics, 6*(1), 63-69. Retrieved from https://www.academia.edu/9671757/Measuring_Scale_Efficiency_Change_Using_a_Translog_Distance_Function

29. Kumbhakar, S. C. (1987). Production frontiers and panel data: an application to US class I railroad. *Journal of Business and Economic Statistics, 5*(2), 249-255. Retrieved from https://ideas.repec.org/a/bes/jbes/52/2/a_249-55.html

30. Lovell, C. K. (1993). *Production Frontiers and Productive Efficiency*. In H. O. Fried & S. S. Schmidt (Eds.), *The Measurement of Productive Efficiency: Techniques and Applications* (pp. 3-67). New York: Oxford University Press. Retrieved from https://www.jstor.org/stable/41770796

31. Marwa, N., & Aziakpono, M. (2016). Technical and Scale Efficiency of Tanzanian Saving and Credit Cooperatives. *The Journal of Developing Areas, 50*(1), 29-46. https://doi.org/10.1353/jda.2016.0000

32. Meher, K., & Getaneh, H. (2019). Impact of determinants of financial distress on the financial sustainability of Ethiopian commercial banks. *Banks and Bank Systems, 14*(3), 187-201. http://dx.doi.org/10.21511/bbs.14(3).2019.16

33. Meher, K., & Zewdu, T. (2020). Determinants of Firm’s Internals & Macroeconomic Factors on Financial Performance of Ethiopian Insurers. *DLasu Business & Economics Review, 29*(2), 71-80. Retrieved from https://www.dlsu.edu.ph/wp-content/uploads/2020/02/meher-012120.pdf

34. Saad, N. M. (2012). An analysis of the efficiency of takaful and insurance companies in Malaysia: a non-parametric approach. *Review of Integrative Business & Economics Research, 1*(1), 33-56. Retrieved from https://www.sibresearch.org/uploads/2/7/9/9/2799227/riber2012-080_33-56.pdf

35. National Bank of Ethiopia. (n.d.). Annual Reports of National Bank of Ethiopia. Retrieved from https://nbebank.com/annual-report/

36. Noulas, A. G., Hatzigayios, T., Lazaridis, J., & Lyroudi, K. (2001). Non-parametric production frontier approach to the study of the efficiency of non-life insurance companies in Greece. *Journal of Financial Management and Analysis, 14*(1), 19-26. Retrieved from https://www.researchgate.net/publication/283428113_Non-Parametric_Production_Frontier_Approach_to_the_Study_of_Efficiency_of_Non-Life_Insurance_Companies_in_Greece

37. Owusu-Ansah, E., Dontwi, I., Seidu, B., Abudulai, G., & Sebil, C. (2010). Technical efficiencies of Ghanaian general insurers. *American Journal of Social and Management Sciences, 1*(1), 75-87. http://dx.doi.org/10.5251/ajsms.2010.1.1.75.87

38. Saad, N. M. (2012). An analysis of the efficiency of takaful and insurance companies in Malaysia: a non-parametric approach. *Review of Integrative Business & Economics Research, 1*(1), 33-56. Retrieved from https://www.sibresearch.org/uploads/2/7/9/9/2799227/riber2012-080_33-56.pdf

39. Seiford, L. M. (1996). Data Envelopment Analysis: The Evolution of State of the Art (1978–1995). *Journal of Productivity Analysis, 7*(2-3), 99-138. Retrieved from https://www.jstor.org/stable/41770796

40. Seiford, L. M., & Thrall, R. M. (1990). Recent Developments in DEA: The Mathematical Approach to Frontier Analysis. *Journal of Econometrics, 46*(1-2), 7-38. https://doi.org/10.1016/0304-4076(90)90045-U

41. Sinha, R. P. (2015). A Dynamic DEA Model for Indian Life Insurance Companies. *Global Business Review, 16*(2), 258-269. https://doi.org/10.1177/0972150914564418

42. Tone, K., & Sahoo, B. K. (2000). Evaluating cost efficiency and returns to scale in the life insurance corporation of India using data envelopment analysis. *Socio-Economic Planning Sciences, 39*(4), 261-285. https://doi.org/10.1016/j.seps.2004.06.001

43. Yao, S., Han, Z., & Feng, G. (2007). On the technical efficiency of China’s insurance industry after WTO accession. *China Economic Review, 18*(1), 66-86. http://dx.doi.org/10.1016/j.chieco.2006.10.005
### APPENDIX A

#### Table A1. Ethiopian general insurance companies, their establishment period and observations

Source: National Bank of Ethiopia (2019).

| S.N. | Name                                         | Types of insurance contract | Establishment year | Data period         | Observations (No. of years) |
|------|----------------------------------------------|-----------------------------|--------------------|---------------------|----------------------------|
| 1    | Ethiopian Insurance Corporation              | Composite                   | 1975               | 2005–2016           | 12                         |
| 2    | Africa Insurance Company                     | Composite                   | 1994               | 2005–2016           | 12                         |
| 3    | Awash insurance company S.C.                 | Composite                   | 1994               | 2005–2016           | 12                         |
| 4    | National Insurance Company of Ethiopia S.C.  | General                     | 1994               | 2005–2016           | 12                         |
| 5    | Nyala Insurance Company S.C.                 | Composite                   | 1995               | 2005–2016           | 12                         |
| 6    | Nile Insurance Company S.C.                  | Composite                   | 1997               | 2005–2016           | 12                         |
| 7    | The United Insurance S.C.                    | Composite                   | 1997               | 2005–2016           | 12                         |
| 8    | Global Insurance Company S.C.                | General                     | 1997               | 2005–2016           | 12                         |
| 9    | NIB insurance Company                         | Composite                   | 2002               | 2005–2016           | 12                         |
| 10   | Lion Insurance Company S.C.                  | General                     | 2007               | 2009–2016           | 8                          |
| 11   | Oromia Insurance Company S.C.                | Composite                   | 2010               | 2011–2016           | 6                          |
| 12   | Ethio-Life and General Insurance S.C.        | Composite                   | 2008               | 2013–2016           | 4                          |
| 13   | Abay Insurance Company                        | General                     | 2010               | 2013–2016           | 4                          |
| 14   | Birhan Insurance Company S.C.                | General                     | 2011               | 2013–2016           | 4                          |
| 15   | Tsehay Insurance S.C.                        | General                     | 2012               | 2013–2016           | 4                          |
| 16   | Lucy Insurance Share Company                 | General                     | 2012               | 2013–2016           | 4                          |
| 17   | Buna Insurance Company                        | General                     | 2012               | 2015–2016           | 2                          |
|      | Total observations                           |                             |                    |                     | 143                        |

### APPENDIX B

#### Table B1. The selected variables of inputs and outputs along with definition

| Variables                        | Definition                                                                                                                                                                                                 |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Inputs                           |                                                                                                                                             |
| Total operating expenses         | Expenses related to operations of the insurance companies, such as salaries and employees’ benefit, administrative and general expense, office rent expense, financial charge, directors’ fixed remuneration, office supplies, depreciation of fixed assets, amortization of intangible assets, bad debts written off, provision for bad debts, board fee, audit fee, and other expenses such as commissions. |
| Total Liability                  | Liabilities such as technical provision, inward business reserve, special reserve-guarantee bonds, special reserve disputed claims, outstanding claims, bank overdraft, short-term loan, due to reinsurers, due to ceding companies, provision for tax, dividend payable, and directors’ remuneration, creditors and accruals, employees liabilities, current account (non-life) and others. |
| Total Shareholder’s fund         | Shareholder’s fund such as paid up capital, share premium, legal reserve, general reserve, retained earnings, inter-business current account, and others.                                                         |
| Outputs                          |                                                                                                                                             |
| Net Premium Earned               | It is the difference between gross earned premiums and reinsurance premiums ceded, or gross earned premiums minus reinsurance premiums ceded.                                                               |
| Investment Income                | Income including dividend income, interest income, rent income, and other income.                                                                                                                       |
## APPENDIX C

### Table C1. Nature of returns to scale from 2005 to 2016

| Year | Company | CRS | VRS | SE | RTS       |
|------|---------|-----|-----|----|-----------|
| 2005 | EIC     | 1.00| 1.00| 1.00| Constant  |
| 2006 | EIC     | 1.00| 1.00| 1.00| Decreasing|
| 2007 | EIC     | 1.00| 1.00| 1.00| Constant  |
| 2008 | EIC     | 1.00| 1.00| 1.00| Constant  |
| 2009 | EIC     | 1.00| 1.00| 1.00| Constant  |
| 2010 | EIC     | 1.00| 1.00| 1.00| Constant  |
| 2011 | EIC     | 1.00| 1.00| 1.00| Constant  |
| 2012 | EIC     | 1.00| 1.00| 1.00| Constant  |
| 2013 | EIC     | 1.00| 1.00| 1.00| Constant  |
| 2014 | EIC     | 1.00| 1.00| 1.00| Constant  |
| 2015 | EIC     | 1.00| 1.00| 1.00| Constant  |
| 2016 | EIC     | 1.00| 1.00| 1.00| Constant  |
| 2005 | Awash   | 0.64| 0.64| 0.99| Constant  |
| 2006 | Awash   | 0.79| 0.79| 1.00| Constant  |
| 2007 | Awash   | 0.69| 0.69| 1.00| Constant  |
| 2008 | Awash   | 0.95| 0.98| 0.97| Decreasing|
| 2009 | Awash   | 0.93| 0.94| 0.99| Decreasing|
| 2010 | Awash   | 1.00| 1.00| 1.00| Constant  |
| 2011 | Awash   | 0.77| 0.80| 0.97| Decreasing|
| 2012 | Awash   | 1.00| 1.00| 1.00| Constant  |
| 2013 | Awash   | 0.94| 0.97| 0.98| Decreasing|
| 2014 | Awash   | 0.97| 1.00| 0.97| Decreasing|
| 2015 | Awash   | 0.95| 0.96| 0.99| Increasing|
| 2016 | Awash   | 0.56| 0.68| 0.83| Increasing|
| 2005 | Global  | 0.51| 0.51| 1.00| Constant  |
| 2006 | Global  | 1.00| 1.00| 1.00| Constant  |
| 2007 | Global  | 1.00| 1.00| 1.00| Constant  |
| 2008 | Global  | 0.46| 0.46| 1.00| Constant  |
| 2009 | Global  | 0.61| 0.61| 1.00| Constant  |
| 2010 | Global  | 0.62| 0.62| 1.00| Constant  |
| 2011 | Global  | 0.78| 0.78| 1.00| Constant  |
| 2012 | Global  | 0.81| 0.81| 1.00| Constant  |
| 2013 | Global  | 1.00| 1.00| 1.00| Constant  |
| 2014 | Global  | 0.83| 0.83| 1.00| Constant  |
| 2015 | Global  | 1.00| 1.00| 1.00| Increasing|
| 2016 | Global  | 1.00| 1.00| 1.00| Constant  |
| 2005 | Nile    | 1.00| 1.00| 1.00| Constant  |
| 2006 | Nile    | 1.00| 1.00| 1.00| Constant  |
| 2007 | Nile    | 1.00| 1.00| 1.00| Constant  |
| 2008 | Nile    | 1.00| 1.00| 1.00| Constant  |
| 2009 | Nile    | 0.88| 0.88| 1.00| Constant  |
| 2010 | Nile    | 1.00| 1.00| 1.00| Constant  |
| 2011 | Nile    | 1.00| 1.00| 1.00| Constant  |
| 2012 | Nile    | 1.00| 1.00| 1.00| Constant  |
| 2013 | Nile    | 1.00| 1.00| 1.00| Constant  |
| 2014 | Nile    | 1.00| 1.00| 1.00| Constant  |
| 2015 | Nile    | 0.79| 0.91| 0.87| Decreasing|
| 2016 | Nile    | 0.71| 0.75| 0.95| Increasing|
| 2005 | Nice    | 1.00| 1.00| 1.00| Constant  |
| 2006 | Nice    | 1.00| 1.00| 1.00| Constant  |
| 2007 | Nice    | 1.00| 1.00| 1.00| Constant  |
| 2008 | Nice    | 1.00| 1.00| 1.00| Constant  |
| Year | Company | CRS | VRS | SE  | RTS       |
|------|---------|-----|-----|-----|-----------|
| 2009 | Nice    | 1.00| 1.00| 1.00| Constant  |
| 2010 | Nice    | 1.00| 1.00| 1.00| Constant  |
| 2011 | Nice    | 1.00| 1.00| 1.00| Constant  |
| 2012 | Nice    | 1.00| 1.00| 1.00| Constant  |
| 2013 | Nice    | 0.96| 0.96| 1.00| Constant  |
| 2014 | Nice    | 0.84| 0.84| 1.00| Decreasing|
| 2015 | Nice    | 0.63| 0.71| 0.89| Increasing|
| 2016 | Nice    | 0.62| 1.00| 0.62| Increasing|
| 2005 | Africa  | 0.78| 0.78| 1.00| Decreasing|
| 2006 | Africa  | 0.81| 0.80| 1.01| Decreasing|
| 2007 | Africa  | 0.71| 0.71| 1.00| Constant  |
| 2008 | Africa  | 1.00| 1.00| 1.00| Constant  |
| 2009 | Africa  | 1.00| 1.00| 1.00| Constant  |
| 2010 | Africa  | 1.00| 1.00| 1.00| Constant  |
| 2011 | Africa  | 1.00| 1.00| 1.00| Constant  |
| 2012 | Africa  | 1.00| 1.00| 1.00| Constant  |
| 2013 | Africa  | 1.00| 1.00| 1.00| Constant  |
| 2014 | Africa  | 1.00| 1.00| 1.00| Constant  |
| 2015 | Africa  | 1.00| 1.00| 1.00| Constant  |
| 2016 | Africa  | 1.00| 1.00| 1.00| Constant  |
| 2009 | Nib     | 0.64| 0.64| 1.00| Constant  |
| 2006 | Nib     | 0.80| 0.82| 0.98| Constant  |
| 2007 | Nib     | 0.58| 0.58| 1.00| Constant  |
| 2008 | Nib     | 0.98| 0.98| 1.00| Constant  |
| 2009 | Nib     | 0.78| 0.78| 1.00| Constant  |
| 2010 | Nib     | 0.80| 0.80| 1.00| Constant  |
| 2011 | Nib     | 0.66| 0.66| 1.00| Constant  |
| 2012 | Nib     | 0.97| 0.97| 1.00| Constant  |
| 2013 | Nib     | 0.70| 0.70| 1.00| Constant  |
| 2014 | Nib     | 0.79| 0.89| 0.89| Constant  |
| 2015 | Nib     | 0.71| 0.75| 0.96| Decreasing|
| 2016 | Nib     | 0.88| 0.90| 0.98| Decreasing|
| 2005 | Nyala   | 0.90| 0.91| 0.99| Decreasing|
| 2006 | Nyala   | 0.89| 1.00| 0.89| Decreasing|
| 2007 | Nyala   | 1.00| 1.00| 1.00| Constant  |
| 2008 | Nyala   | 1.00| 1.00| 1.00| Constant  |
| 2009 | Nyala   | 1.00| 1.00| 1.00| Constant  |
| 2010 | Nyala   | 1.00| 1.00| 1.00| Constant  |
| 2011 | Nyala   | 1.00| 1.00| 1.00| Constant  |
| 2012 | Nyala   | 1.00| 1.00| 1.00| Constant  |
| 2013 | Nyala   | 1.00| 1.00| 1.00| Constant  |
| 2014 | Nyala   | 0.57| 0.57| 1.00| Constant  |
| 2015 | Nyala   | 1.00| 1.00| 1.00| Decreasing|
| 2016 | Nyala   | 0.70| 0.76| 0.91| Increasing|
| 2005 | Unic    | 1.00| 1.00| 1.00| Constant  |
| 2006 | Unic    | 1.00| 1.00| 1.00| Constant  |
| 2007 | Unic    | 1.00| 1.00| 1.00| Constant  |
| 2008 | Unic    | 1.00| 1.00| 1.00| Constant  |
| 2009 | Unic    | 0.97| 0.97| 1.00| Constant  |
| 2010 | Unic    | 1.00| 1.00| 1.00| Constant  |
| 2011 | Unic    | 0.92| 0.99| 0.92| Decreasing|
| 2012 | Unic    | 0.98| 1.00| 0.98| Constant  |
| 2013 | Unic    | 0.74| 0.74| 1.00| Constant  |
| 2014 | Unic    | 0.87| 0.87| 1.00| Constant  |
Table C1 (cont.). Nature of returns to scale from 2005 to 2016

| Year | Company | CRS   | VRS   | SE   | RTS     |
|------|---------|-------|-------|------|---------|
| 2015 | Unic    | 0.56  | 0.56  | 1.00 | Decreasing |
| 2016 | Unic    | 0.60  | 0.62  | 0.98 | Decreasing |
| 2009 | Lion    | 0.85  | 0.85  | 1.00 | Constant |
| 2010 | Lion    | 1.00  | 1.00  | 1.00 | Constant |
| 2011 | Lion    | 1.00  | 1.00  | 1.00 | Constant |
| 2012 | Lion    | 1.00  | 1.00  | 1.00 | Constant |
| 2013 | Lion    | 1.00  | 1.00  | 1.00 | Constant |
| 2014 | Lion    | 0.72  | 0.84  | 0.86 | Increasing |
| 2015 | Lion    | 0.60  | 0.65  | 0.92 | Increasing |
| 2016 | Lion    | 0.78  | 1.00  | 0.78 | Increasing |
| 2012 | Oromia  | 1.00  | 1.00  | 1.00 | Constant |
| 2013 | Oromia  | 1.00  | 1.00  | 1.00 | Constant |
| 2014 | Oromia  | 0.84  | 0.91  | 0.92 | Increasing |
| 2015 | Oromia  | 0.86  | 0.88  | 0.98 | Increasing |
| 2016 | Oromia  | 0.84  | 0.94  | 0.89 | Increasing |
| 2013 | Abay    | 0.58  | 0.75  | 0.77 | Increasing |
| 2014 | Abay    | 0.58  | 0.62  | 0.94 | Decreasing |
| 2015 | Abay    | 0.58  | 0.71  | 0.81 | Increasing |
| 2016 | Abay    | 0.90  | 0.91  | 0.99 | Decreasing |
| 2013 | Berhan  | 0.86  | 0.86  | 1.00 | Constant |
| 2014 | Berhan  | 0.69  | 0.74  | 0.93 | Decreasing |
| 2015 | Berhan  | 1.00  | 1.00  | 1.00 | Increasing |
| 2016 | Berhan  | 0.53  | 1.00  | 0.53 | Increasing |
| 2013 | Tsehay  | 0.61  | 0.61  | 1.00 | Constant |
| 2014 | Tsehay  | 1.00  | 1.00  | 1.00 | Constant |
| 2015 | Tsehay  | 0.73  | 0.85  | 0.85 | Increasing |
| 2016 | Tsehay  | 0.46  | 0.98  | 0.46 | Increasing |
| 2013 | ELiG    | 0.32  | 0.32  | 1.00 | Constant |
| 2014 | ELiG    | 0.52  | 0.52  | 1.00 | Constant |
| 2015 | ELiG    | 0.65  | 1.00  | 0.65 | Increasing |
| 2016 | ELiG    | 0.63  | 1.00  | 0.63 | Increasing |
| 2013 | Lucy    | 0.21  | 0.21  | 1.00 | Constant |
| 2014 | Lucy    | 0.28  | 1.00  | 0.28 | Constant |
| 2015 | Lucy    | 0.28  | 0.86  | 0.33 | Increasing |
| 2016 | Lucy    | 0.60  | 1.00  | 0.60 | Increasing |
| 2015 | Bunna   | 0.32  | 1.00  | 0.32 | Increasing |
| 2016 | Bunna   | 0.44  | 0.81  | 0.54 | Increasing |
| **Average** |     | 0.84  | 0.89  | 0.95 | – |