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BANKING & FINANCE | RESEARCH ARTICLE

Analysis of Takaful vs. Conventional insurance firms' efficiency: Two-stage DEA of Saudi Arabia's insurance market

Tarifa Almulhim^{1*}

Abstract: Despite the remarkable growth in the insurance industry over the past two decades, few studies evaluate the performance of Takaful vs. conventional insurance firms with focus on the standard structure of production as a two-stage process, that is, operations and profitability. Thus, this research examines the performance of Saudi Arabia's insurance market using a two-stage data envelopment analysis to assess the efficiency of the two production stages and accordingly, define the leader stage. The empirical results obtained using data for 26 conventional and seven Takaful insurance firms for 2014–2017 indicate declining average efficiency scores for both firm types. In other words, Saudi Arabia's insurance market warrants new consolidation and foreign participation regulations to assist firms in becoming dynamic and strong. This study makes a significant contribution given the dearth of an exclusive analysis on the two-stage efficiency of Saudi Arabia's Takaful and conventional insurance firms. Further, it offers key implications for decision makers, regulators, and managers associated with the insurance industry in Saudi Arabia and other emerging insurance markets.

Subjects: Insurance; Operational Research / Management Science; Operations Management

ABOUT THE AUTHOR

Tarifa Almulhim received a bachelor's degree in mathematics from King Faisal University, Alhassa, Saudi Arabia, in 2005; a master's in science degree in operational research and applied statistics from the University of Salford, Salford, United Kingdom, in 2010; and a PhD in business and management (operational research) from the University of Manchester, Manchester, United Kingdom, in December 2014. She is, at present, the vice dean at the College of Business Administration and an assistant professor of quantitative methods at King Faisal University. She has published four research papers related to operational research, risk and insurance, decision theory, and fuzzy logic systems in international journals. Her current research interests include operational research, operations management, risk and insurance, multiple criteria decision analysis under uncertainties, decision theory, and fuzzy logic systems.

PUBLIC INTEREST STATEMENT

This study aims to evaluate the performance of Saudi Arabia's insurance industry, particularly Takaful and conventional insurance firms, during 2014–2017 using a two-stage data envelopment analysis (DEA) method. The efficiency scores are based on data from 33 insurance firms listed on the Saudi stock exchange (Tadawul), of which seven are Takaful firms and 26 are conventional firms. In addition, this research investigates whether the operations and profitability stage is the optimal or leader stage in insurance firms. The key findings highlight that the performance in terms of average efficiency has monotonically decreased for both Takaful and conventional insurance firms. This study can assist regulators and managers attempting to develop Saudi Arabia's insurance industry and improve its performance.

Keywords: Takaful firms; Saudi Arabian insurance market; two-stage data envelopment analysis; efficiency

1. Introduction

The development of the insurance industry has been commonly acknowledged as a significant catalyst for sustainable economic growth across the world (Ward & Zurbruegg, 2000). The insurance industry has witnessed substantial and accelerated growth over the past two decades (Arena, 2008). Numerous studies have been devoted to understanding insurance market activities and measuring insurance efficiency in both industrialized and developed countries. While there is extensive research on the insurance markets of developed countries, the coverage of the insurance industry in developing countries, particularly the emerging markets of Asia and more specifically, Saudi Arabia, remains narrow.

This study focuses on Saudi Arabia's insurance industry because it is the largest and oldest insurance market among the Cooperation Council for the Arab States of the Gulf, also known as the Gulf Cooperation Council (GCC),¹ countries (Samargandi, Fidrmuc, & Ghosh, 2014). In addition, Saudi Arabia is the largest economy in the Arab region. As per OPEC, it has the second largest (after Venezuela) proven oil reserves in the world, and it is a member of the Group of Twenty (G-20). The 2017 national institution statistics for GCC countries reports that Saudi Arabia's population accounts for 65% of the GCC's population. Saudi Arabia's insurance industry has been significantly growing over the past few years owing to the application of actuarial pricing in 2013 and the increasing demand through economic development projects consistent with the 2030 vision. According to Albilad Capital (2015) report, Saudi Arabia's insurance industry is the second largest in the Gulf region: it is valued at US \$9.5 billion with a 16% growth rate driven by the increase in medical and motor coverage, which contributed to 81% of the insurance market during 2015.

Insurance activities are still relatively new to Saudi Arabia, where the Law on Supervision of Cooperative Insurance Companies was enacted at the end of 2003 and its regulations were implemented in 2004. The Saudi Arabian Monetary Authority (SAMA) is responsible for regulating the Saudi insurance sector, licensing insurance firms, and analysing the market. In addition to SAMA, Saudi Arabia follows a cooperative insurance model called Islamic insurance (Takaful), which is an Islamic or Shari'ah-compliant alternative to conventional insurance. The term Takaful originated from the Arabic word "kafal" denoting assurance or responsibility (Jamil & Akhter, 2016). Currently, there are two forms of insurance operated and licensed in Saudi Arabia, conventional and Takaful insurance.

Like any insurance sector in the world, Saudi Arabia's insurance industry has a standard structure, that is, a production process comprising two stages, operations and profitability. While some studies have evaluated the overall performance of Saudi Arabia's insurance companies, their efficiency in the two-stage production process remains insufficiently explored. These concerns can be summarized into the following questions. How efficient are conventional and Takaful insurance companies in the two production stages of operations and profitability? How do companies' decision makers ascertain which is the dominant stage in their overall performance? To the best of the author's knowledge, no research has investigated the efficiency of Saudi Arabia's Takaful and conventional insurance firms in the two-stage production process and their order of priority on the basis of the lead-follow concept. This study aims to bridge this gap by applying the two-stage data envelopment analysis (DEA) (Despotis, Sotiros, & Koronakos, 2016) to evaluate the efficiency of 26 conventional and seven Takaful insurance firms in the Saudi market in the context of operations and profitability. In addition, it adopts Li, Chen, Cook, Zhang, and Zhu (2018) extended method to determine the relationship between the firms' performance and the two sub-stages during 2014–2017. Further, this study identifies which among the two sub-stages is the leader stage to improve our understanding on determining overall efficiency in the two types of insurance firms. It offers insight into the performance of Takaful operators by comparing their profit-sharing root operations with those of conventional insurance firms. Finally, this research offers recommendations for both researchers and regulators in the insurance sector.

The remainder of this paper is structured as follows. Section 2 provides an overview of theoretical papers on efficiency and the empirical literature on Saudi Arabia's insurance industry. Section 3 describes the data and research methodologies utilized in this study. Section 4 presents the empirical analysis and discusses its major findings. Section 5 concludes the paper with a summary of our key findings.

2. Literature review

The concept of efficiency evaluation has been predominant in the insurance literature. Data envelopment analysis (DEA), introduced by Charnes, Cooper, and Rhodes (1978), is a non-parametric method to assess the efficiency of decision-making units (DMUs) in a single stage that uses multiple inputs to yield multiple outputs. The DEA technique has been widely used to evaluate the performance and efficiency of the insurance industry. This section reviews pertinent efficiency studies in the context of insurance and particularly, research on Saudi Arabia's insurance market.

A majority of research on the efficiency of conventional insurance industries focuses on the United States and other developed countries. Cummins and Zi (1998) perform a DEA and mathematical programming to examine the efficiency of US insurance companies from 1988 to 1992 and deduce that the DEA is a better approach to evaluate insurance industry efficiency. Diacon, Starkey, and Obrien (2002) assess the pure technical and scale efficiencies of 450 insurance firms across 15 European countries and conclude the average technical efficiency declined during 1996–1999. Eling and Luhnen (2010) use DEA to perform a comprehensive efficiency assessment of the global insurance industry. Kaffash and Marra (2017) examine 620 papers published in journals indexed in the Web of Science database during 1985–2016 and employ DEA approaches with focus on financial services (e.g. insurance).

While large numbers of studies evaluate the efficiency of conventional insurance, few pay attention to the efficiency of Takaful insurance. Saad, Majid, Yusof, Duasa, and Rahman (2006) measure the efficiency of Malaysia's life insurance market using data for Takaful and conventional insurance firms. Their findings indicate that conventional firms perform better than Takaful firms and Takaful companies should grow to their optimal size to improve their efficiency score. Kader, Adams, and Hardwick (2009) conduct a DEA to analyse the cost efficiency of 26 Takaful insurance firms in 10 Islamic countries from 2004 to 2006 and indicate that the size of a firm and its board as well as product specialization positively impact Takaful insurance firms' cost efficiency. Ismail, Alhabshi, and Bacha (2011) examine the efficiency of Takaful and conventional insurance firms in Malaysia from 2004 to 2009 and conclude that the efficiency score of Tankful firms is low. Accordingly, they recommend that Takaful companies should decrease their organizational and management expenses to improve their efficiency scores.

Al-Amri, Gattoufi, and Al-Muharrami (2012) analyse the performance of the insurance sector in GCC countries and present a comparative analysis of its different units between 2005 and 2007. Their results reveal that the efficiency of GCC's insurance industry was moderate and there is scope for improvement. However, Al-Amri *et al.*'s study is limited to four insurance companies and thus, cannot be considered representative of Saudi Arabia's insurance sector. Akhtar (2018) examines the performance of Saudi Arabia's Takaful and conventional insurance companies during 2010–2015 by conducting a DEA and recommend that Takaful and large conventional insurance firms must follow the industry's best practices to improve their efficiency and productivity levels. However, Akhtar considers the production process as a single stage and ignores the intermediate stage, which poses limitations when identifying the sources of inefficiency. Further, Akhtar's (2018) study ignores the fact that the production process of Saudi Arabia's insurance industry, like any insurance sector in the world, is a standard structure comprising two stages, operations and profitability.

Traditional DEA considers the behaviour of decision-making units to be a black box and disregards the intermediate stages, thus detrimentally impacting high overall efficiency scores (Kao, 2009). To overcome this issue, the insurance literature has proposed several DEA frameworks with network systems including internal processes. Kao and Hwang (2008) argue an intermediate stage combining inputs with outputs must be considered in performance analyses to derive a precise overview of insurance

companies' performance. Using data on non-life insurance companies from Taiwan, they propose a novel relational DEA approach to evaluate decomposition efficiency in the two-stage production process by considering output variables in the first stage as input variables in the second stage. Cummins, Weiss, Xie, and Zi (2010) employ a two-stage DEA to examine the efficiency scores of insurance firms providing life health and property liability products during 1993–2006. Huang and Martin (2013) evaluate the efficiency of non-life insurance firms in four of the world's fastest growing industries (Brazil, Russia, India, and China) during 2000–2008 using a multi-stage DEA approach. Their study captures inefficiencies attributable to external environmental circumstances, thus implying that country-specific environmental circumstances have a strong effect on the insurance industry. Despotis et al. (2016) present a novel network DEA method to assess multi-stage efficiencies. Their proposed approach overcomes the lack of generality in existing multi-stage DEA approaches and offers unique and unbiased efficiency scores for the two-stage production process while treating each stage equally (Despotis et al., 2016).

However, the two-stage DEA approach has been criticized for failing to define a leader stage. Liang, Yang, Cook, and Zhu (2008) argue the need to understand the relationship among the two stages and conclude that identifying the inefficient stage in a system is important to increase its efficiency by excluding inputs that are actually pending outputs from the efficient stage. Consequently, the authors develop an approach to determine the leader stage between the two stages; more specifically, they extend Despotis et al.'s (2016) study to develop a network DEA with a Pareto solution to examine for the dominant stage.

A survey of the extant literature highlights that research measuring efficiency in multiple stages and identifying the leader stage have neglected the insurance markets, particularly Saudi Arabian insurance market with its two insurance types (conventional and Takaful). Thus, using Despotis et al.'s (2016) approach to estimate two-stage efficiencies, this study evaluates the efficiency of conventional and Takaful insurance companies in Saudi Arabia. In addition, it applies Li et al.'s (2018) proposed approach to determine the leader among the two stages.

3. Methodology and data description

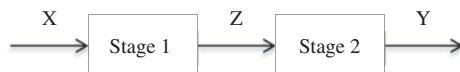
3.1. Methodology

Despotis et al. (2016) propose their composition approach using a bi-objective program model. They use typical DEA scores to determine the ideal efficiency point for each stage and the bi-objective program model to locate a point on the Pareto front by minimizing the maximum weighted deviation from the ideal point in the objective function space (Despotis et al., 2016; Li et al., 2018). Unlike existing DEA methods, Despotis et al.'s (2016) approach offers unique efficiency scores and treats each stage equivalently.

Figure 1 illustrates the division of the two-stage configuration system into two subsystems of a series, in which the first stage will be the inputs of the second stage.

Consider the following basic notations (Despotis et al., 2016; Li et al., 2018): $j \in J = 1, 2, \dots, n$ is the index of n DMUs; $j_o \in J$ is the evaluated DMU; $X_j = (x_{ij}, i = 1, 2, \dots, m)$ is the vector of stage-one inputs utilized by DMU_j ; $Z_j = (z_{pj}, p = 1, 2, \dots, q)$ is the vector of intermediate variables for DMU_j ; $Y_j = (y_{rj}, r = 1, 2, \dots, s)$ is the vector of inputs in the second stage utilized by DMU_j ; $\eta = (\eta_1, \eta_2, \dots, \eta_m)$ is the vector of weights for stage-one inputs in the fractional model; $v = (v_1, v_2, \dots, v_m)$ is the weights vector for stage-one inputs in the linear model; $\varphi = (\varphi_1, \varphi_2, \dots, \varphi_q)$ is the weights vector for the intermediate variables in the fractional model; $w = (w_1, w_2, \dots, w_q)$ is the weights vector for the

Figure 1. Series of two-stage processes.



intermediate variables in the linear model; $\omega = (\omega_1, \omega_2, \dots, \omega_s)$ is the weights vector for stage-two outputs in the fractional model; $u = (u_1, u_2, \dots, u_s)$ is the weights vector for stage-two outputs in the linear model; e_j^o is the overall efficiency of DMU_j , e_j^k is the efficiency of stage k for DMU_j , $k = 1, 2$; E_j^k is the independent efficiency score of stage k for DMU_j , $k = 1, 2$; $e_j^{k,L}$ is the lower bound of stage k 's efficiency for DMU_j , $k = 1, 2$; and $e_j^{k,U}$ is the upper bound of stage k 's efficiency for DMU_j , $k = 1, 2$.

Consider a basic constant-returns-to-scale-DEA (CRS-DEA) model that evaluates the efficiency of the first and second stages to independently assess DMU_{j_o} (Despotis et al., 2016; Kao & Hwang, 2008);

$$E_{j_o}^1 = \max \frac{\varphi Z_{j_o}}{\eta X_{j_o}},$$

s.t.

$$\varphi Z_j - \eta X_j \leq 0, j = 1, \dots, n,$$

$$\omega Y_j - \varphi Z_j \leq 0, j = 1, \dots, n,$$

$$\varphi \geq \varepsilon, \eta \geq \varepsilon, \omega \geq \varepsilon. \tag{1}$$

$$E_{j_o}^2 = \max \frac{\omega Y_{j_o}}{\varphi Z_{j_o}}$$

s.t.

$$\varphi Z_j - \eta X_j \leq 0, j = 1, \dots, n,$$

$$\omega Y_j - \varphi Z_j \leq 0, j = 1, \dots, n,$$

$$\varphi \geq \varepsilon, \eta \geq \varepsilon, \omega \geq \varepsilon, \tag{2}$$

where ε is a non-Archimedean constant (see Amin & Toloo, 2004).

Despotis et al. (2016) propose the following bi-objective program model to evaluate the efficiencies of the two stages;

$$\max wZ_{j_o}$$

$$\max \frac{uY_{j_o}}{wZ_{j_o}}$$

s.t.

$$vX_{j_o} = 1$$

$$wZ_j - vX_j \leq 0, j = 1, \dots, n,$$

$$uY_j - wZ_j \leq 0, j = 1, \dots, n$$

$$v \geq \varepsilon, w \geq \varepsilon, u \geq \varepsilon. \tag{3}$$

Vector $(E_{j_o}^1, E_{j_o}^2)$ establishes the ideal point of the bi-objective program (3) in the objective functions space. The optimal solution for model (3) can be achieved using a two-phase procedure, which is equivalent to utilizing lexicographically L^∞ and L^1 norms (Despotis et al., 2016).

In the first phase, Despotis et al. (2016) assume no specific evidence prioritizing one of the two stages and then employ the unweighted Tchebycheff norm to their assessments as follows;

$$\begin{aligned}
 & \min \delta, \\
 & \text{s.t.} \\
 & E_{j_0}^1 - wZ_{j_0} \leq \delta, \\
 & (E_{j_0}^2 - \delta)wZ_{j_0} - uY_{j_0} \leq 0, \\
 & vX_{j_0} = 1 \\
 & wZ_j - vX_j \leq 0, \quad j = 1, \dots, n, \\
 & uY_j - wZ_j \leq 0, \quad j = 1, \dots, n \\
 & v \geq \varepsilon, w \geq \varepsilon, u \geq \varepsilon, \delta \geq 0.
 \end{aligned} \tag{4}$$

While model (4) is non-linear, it can be easily solved using a bisection search (Despotis, 1996). Let $(\delta^*, v^*, w^*, u^*)$ be an optimal solution to model (4) and

$$e_{j_0}^{1*} = \frac{w^*Z_{j_0}}{v^*X_{j_0}} = w^*Z_{j_0}, e_{j_0}^{2*} = \frac{u^*Y_{j_0}}{w^*Z_{j_0}}.$$

In the second phase, Despotis et al. (2016) apply an equivalent to utilize the lexicographically L1 norm for the optimal solutions set of model (4) to determine a Pareto optimal solution for Equation (3) as follows;

$$\begin{aligned}
 & \max s_1 + s_2, \\
 & \text{s.t.} \\
 & E_{j_0}^1 - wZ_{j_0} + s_1 = \delta^*, \\
 & (E_{j_0}^2 - \delta)wZ_{j_0} - uY_{j_0} + s_2w^*Z_{j_0} = 0, \\
 & vX_{j_0} = 1 \\
 & wZ_j - vX_j \leq 0, \quad j = 1, \dots, n, \\
 & uY_j - wZ_j \leq 0, \quad j = 1, \dots, n \\
 & v \geq \varepsilon, w \geq \varepsilon, u \geq 0, \\
 & \delta^* \geq s_1 \geq 0, \delta^* \geq s_2 \geq 0.
 \end{aligned} \tag{5}$$

In model (5), δ^* is the optimal value of the objective function in model (4) and $w^*Z_{j_0}$ is the optimal virtual intermediate measure derived by model (4). The optimal solution $(\hat{v}, \hat{w}, \hat{u})$ for model (5), which is the Pareto optimal solution from model (3); unit j_0 's efficiency scores in the first and second stages; and the overall system efficiency is, respectively, as follows:

$$\hat{e}_{j_0}^1 = \frac{\hat{w}Z_{j_0}}{\hat{v}X_{j_0}} = \hat{w}Z_{j_0}, \hat{e}_{j_0}^2 = \frac{\hat{u}Y_{j_0}}{\hat{w}Z_{j_0}}, \hat{e}_{j_0}^0 = \frac{\hat{u}Y_{j_0}}{\hat{v}X_{j_0}} = \hat{u}Y_{j_0}$$

$$\text{Since } \hat{e}_{j_0}^0 = \hat{e}_{j_0}^1 \cdot \hat{e}_{j_0}^2, \hat{e}_{j_0}^2 = \frac{\hat{e}_{j_0}^0}{\hat{e}_{j_0}^1}.$$

Li et al. (2018) extend Despotis et al.'s (2016) study to produce a Pareto solution and define the dominant stage in a two-stage DEA. They show that the global optimal solution can be identified by comparing differences in the efficiency scores between the upper and lower bounds of the two

stages (Li et al., 2018). If $(e_j^{1,U} - e_j^{1,L}) > (e_j^{2,U} - e_j^{2,L})$, then the first stage will be the leader; however, if $(e_j^{1,U} - e_j^{1,L}) < (e_j^{2,U} - e_j^{2,L})$, then the second stage is the leader (Li et al., 2018).

The ideal point in Despotis et al. (2016) is (E_j^1, E_j^2) and in Li et al.'s (2018) extended model, it is $(e_j^{1,U}, e_j^{2,U})$. Li et al. (2018) employ the augmented weighted Tchebycheff metric to solve model (3) to determine $(e_j^{1,L}, e_j^{2,L})$. For a detailed review of the extended model, see Li et al. (2018).

3.2. Data description

This study analyses data for 33 insurance firms listed on Saudi's stock market, Tadawul (www.tadawul.com.sa), of which seven are Takaful firms and 26 are conventional insurance firms. The data are obtained from annual financial reports published by the insurance firms during 2014–2017. For the list of the companies included in this study, see Appendix I.

Drawing on Kao and Hwang (2008) and Akhtar (2018), this study includes the following set of variables: equity (X1), net claims incurred (X2) and general and administrative expenses (X3) are input variables; net premium earned (Y1) and investment and management fee income (Y2) are final output variables; and direct written premium (Z1) and reinsurance premium (Z2) are intermediate variables. The first stage is defined as the operational (or premium) stage, and the second stage is the profitability/investment stage.

4. Empirical results and discussion

In Tables 1 and 2, the second and third columns present the stage-one efficiency scores, $\hat{e}_j^1, j = 1, 2, \dots, 33$, and its rank; the fourth and fifth columns show the stage-two efficiency scores, $\hat{e}_j^2, j = 1, 2, \dots, 33$, and its rank; and the last two columns list the overall efficiency scores, $\hat{e}_j^0, j = 1, 2, \dots, 33$, and its rank.

A comparison of the efficiency ranking derived for the two stages (operational and profitability) and the overall efficiency scores for the production process highlights four companies with the overall efficiency of one in both stages during 2014–2016. The results benchmark two Takaful companies, SABB Takaful (No. 31) and Aljazira Takaful Taawuni Co. (No. 29), for 2014 and 2016. Further, Tables 1 and 2 indicate that Bupa Arabia for Cooperative Insurance (No. 10) reports consistent efficiency in both sub-stages and overall efficiency in 2015. In 2017, The Company for Cooperative Insurance (Tawuniya) (No. 21) is benchmarked in the operational stage (first stage) and has high overall efficiency scores during the entire production process. According to SAMA (2017), Bupa Arabia for Cooperative Insurance and Tawuniya are the largest insurance firms (in assets) in Saudi Arabia and operate in diversified business areas (e.g. vehicle, marine, and health insurance as well as protection and savings).

Among the 33 studied firms, Takaful companies are among the top 10 companies in terms of overall efficiency scores and yet, none of them perform efficiently in both sub-processes (see Tables 1 and 2). Al-Rajhi Company for Cooperative Insurance (No. 27), Aljazira Takaful Taawuni Company (No. 29), SABB Takaful (No. 31), and Salama Cooperative Insurance Company (No. 32) are among the top 10 companies for 2014. Al-Rajhi Company for Cooperative Insurance (No. 27), Aljazira Takaful Taawuni Company (No. 29), and SABB Takaful (No. 31) rank among the top 10 companies for 2015 and 2016. Al-Rajhi Company for Cooperative Insurance (No. 27) and Salama Cooperative Insurance Company (No. 32) rank fifth and eighth in 2017. Al-Rajhi Company for Cooperative Insurance (No. 27) is among the top five in 2014, 2016, and 2017. SABB Takaful (No. 31) ranks among the top five in 2014 and 2016. Evidently, some firms report significant differences in their performance ranking between the two sub-processes. For example, in 2017, AXA Cooperative Insurance Company (No. 9) and SABB Takaful (No. 31) are among the top 10 firms but perform unsatisfactorily in the second stage compared with the first stage. While the overall efficiency assists decision makers in identifying the sub-stage contributing to inefficiencies, it is important to determine the dominant stage.

Table 1. Efficiency measures and their ranks for 33 insurance companies in Saudi Arabia, 2014–2015

DMU	2014						2015					
	\hat{e}^1	Rank	\hat{e}^2		\hat{e}^0	Rank	\hat{e}^1	Rank	\hat{e}^2	Rank	\hat{e}^0	Rank
1	0.8976	15	0.4664	27	0.4186	22	0.8914	11	0.6202	18	0.5528	12
2	0.3683	30	0.7292	17	0.2685	30	0.6653	23	0.5555	22	0.3696	23
3	0.3806	29	0.9798	5	0.3729	25	0.507	30	0.8413	9	0.4265	21
4	0.5765	27	0.3292	33	0.1898	32	0.7828	16	0.0966	33	0.0756	33
5	1	1	0.5921	23	0.5921	11	1	1	0.5185	25	0.5185	15
6	0.4229	28	1	1	0.4229	21	0.6267	25	0.5425	23	0.34	25
7	1	1	0.625	21	0.625	10	0.711	20	0.6042	20	0.4296	20
8	0.8332	17	0.5209	25	0.4341	20	0.8048	14	0.8947	7	0.7201	3
9	0.5884	25	0.8381	10	0.4932	14	1	1	0.8836	8	0.8836	2
10	1	1	0.8637	9	0.8637	2	1	1	1	1	1	1
11	0.699	20	0.7215	18	0.5043	13	0.4667	31	0.7412	11	0.3459	24
12	0.9578	12	0.3678	31	0.3523	26	0.7545	17	0.4288	28	0.3235	26
13	0.7603	19	0.4523	28	0.3439	27	0.5879	29	0.4718	26	0.2773	28
14	0.6746	21	0.5575	24	0.3761	24	0.6927	22	0.3599	30	0.2493	31
15	0.6349	23	0.7322	15	0.4649	17	0.7034	21	0.9556	3	0.6721	6
16	1	1	0.381	30	0.381	23	1	1	0.2567	31	0.2567	29
17	1	1	0.6758	19	0.6758	6	1	1	0.7038	14	0.7038	4
18	0.1846	33	0.9983	4	0.1843	33	0.6278	24	0.4006	29	0.2515	30
19	0.9966	10	0.6367	20	0.6345	9	0.8657	13	0.5335	24	0.4619	17
20	0.3006	31	0.9497	6	0.2855	29	0.6096	26	0.6675	15	0.4069	22
21	0.5839	26	0.7912	13	0.462	18	0.5942	28	0.8062	10	0.4791	16
22	0.9032	14	0.7316	16	0.6608	7	0.7515	18	0.908	6	0.6823	5
23	1	1	0.8312	11	0.8312	3	0.8839	12	0.6168	19	0.5452	13
24	0.8598	16	0.6232	22	0.5359	12	0.9017	10	0.5852	21	0.5277	14
25	1	1	0.483	26	0.483	15	1	1	0.6349	16	0.6349	8
26	0.9785	11	0.4488	29	0.4391	19	1	1	0.4341	27	0.4341	18
27	0.8141	18	0.9126	8	0.743	5	0.6065	27	1	1	0.6065	10
28	1	1	0.3373	32	0.3373	28	0.9879	9	0.2399	32	0.237	32
29	0.6559	22	1	1	0.6559	8	0.7161	19	0.9286	4	0.665	7
30	0.6342	24	0.738	14	0.468	16	0.7881	15	0.74	12	0.5832	11
31	1	1	1	1	1	1	1	1	0.6223	17	0.6223	9
32	0.9327	13	0.8041	12	0.7499	4	0.4645	32	0.9257	5	0.43	19
33	0.272	32	0.9395	7	0.2555	31	0.3947	33	0.7284	13	0.2875	27

Note: The rows highlighted in grey refer to Takaful firms.

Table 3 shows that the average efficiency scores for Saudi Arabia's Takaful and conventional insurance companies during 2014–2017 is 0.44, which is less than the score (0.61) estimated by Al-Amri et al. (2012) for GCC firms. Similarly, it is less than the average efficiency score (0.83) presented by Akhtar (2018) for both firm types from 2010 to 2014. Thus, exploring production process efficiency in terms of operations and profitability can offer deeper insight, particularly from a managerial perspective.

Table 3 also shows that Saudi Arabia's insurance market is characterized by vast irregularities during the study period, with average efficiency scores for Takaful and conventional firms ranging between 0.05 and 1.00. Determining production process efficiency on the basis of operational and

Table 2. Efficiency measures and their ranks for 33 insurance companies in Saudi Arabia, 2016 and 2017

DMU	2016						2017					
	\hat{e}^1	Rank	\hat{e}^2	Rank	\hat{e}^0	Rank	\hat{e}^1	Rank	\hat{e}^2	Rank	\hat{e}^0	Rank
1	0.827	14	0.5245	26	0.4338	19	0.2306	29	0.4318	26	0.0996	26
2	0.2098	32	0.6212	20	0.1303	32	0.1495	30	0.6324	21	0.0945	28
3	0.2845	31	0.6508	18	0.1852	29	0.3129	21	0.7169	16	0.2243	18
4	0.4076	26	0.509	27	0.2075	27	0.2826	26	0.3561	27	0.1006	25
5	0.953	11	0.5488	25	0.523	14	1	1	0.6033	23	0.6033	7
6	0.3515	29	0.9694	3	0.3407	22	0.4116	18	0.9289	5	0.3823	13
7	0.6506	23	0.7015	15	0.4564	17	0.287	24	0.6674	18	0.1915	22
8	0.9899	6	0.5589	24	0.5533	11	0.425	17	0.4971	25	0.2112	20
9	0.7238	21	0.7975	8	0.5772	10	0.5464	14	0.8337	8	0.4556	9
10	0.9715	9	0.9715	2	0.9438	2	0.7032	8	0.9408	4	0.6616	6
11	0.4076	26	0.7253	12	0.2957	24	0.2834	25	0.8456	7	0.2396	17
12	0.6353	24	0.4057	29	0.2577	25	0.2551	27	0.3234	30	0.0825	30
13	0.3654	28	0.49	28	0.179	30	0.3076	22	0.3532	28	0.1086	24
14	1	1	0.3917	30	0.3917	21	0.6674	9	0.3352	29	0.2237	19
15	0.8906	12	0.7839	9	0.6981	6	1	1	0.773	10	0.773	3
16	0.9695	10	0.5961	23	0.5779	9	0.4496	16	0.5885	24	0.2646	14
17	0.6533	22	0.8008	7	0.5232	13	0.5976	11	0.7309	15	0.4368	10
18	0.7305	19	0.6134	21	0.4481	18	0.3233	20	0.6353	20	0.2054	21
19	0.813	15	0.6539	17	0.5316	12	1	1	0.6937	17	0.6937	5
20	0.3242	30	0.6069	22	0.1968	28	0.2327	28	0.7461	14	0.1736	23
21	1	1	0.8293	6	0.8293	3	1	1	0.8673	6	0.8673	1
22	0.7817	16	0.7773	10	0.6077	8	1	1	0.7635	12	0.7635	4
23	0.7252	20	0.7101	14	0.5149	16	0.5582	13	0.7682	11	0.4288	12
24	0.8346	13	0.1015	33	0.0847	33	0.5385	15	0.159	33	0.0856	29
25	0.9742	8	0.6416	19	0.6251	7	0.3927	19	0.6274	22	0.2464	15
26	1	1	0.3383	31	0.3383	23	0.9219	6	0.2602	32	0.2398	16
27	0.7681	17	0.9163	5	0.7038	5	0.8472	7	0.954	3	0.8082	2
28	0.9846	7	0.2396	32	0.2359	26	0.2876	23	0.2846	31	0.0818	32
29	1	1	1	1	1	1	0.0509	33	1	1	0.0509	33
30	0.7462	18	0.6984	16	0.5211	15	0.5748	12	0.7513	13	0.4318	11
31	1	1	0.7451	11	0.7451	4	0.1286	31	0.6414	19	0.0825	30
32	0.5428	25	0.7236	13	0.3928	20	0.6313	10	0.8307	9	0.5244	8
33	0.1784	33	0.9559	4	0.1706	31	0.0986	32	0.996	2	0.0982	27

Note: The rows highlighted in grey refer to Takaful firms.

profitability efficiency scores will highlight the desired level of outputs a firm should supply while engaging efficient inputs during the intermediate stage. Table 1–3 present the results. First, the annual average efficiency of Saudi Arabia’s Takaful companies is relatively higher than that of conventional insurance companies during 2014–2016. In other words, Takaful insurance firms perform better than conventional insurance firms in the Saudi market. A possible explanation for this result is that companies tend to choose and transform the optimal combination of inputs and intermediate variables into optimal outputs through several lines of insurance business (e.g. motor and health insurance). Thus, as Jamil and Akhter (2016) and Rahman, Akhter, and Khan (2017) highlight, Takaful insurance firms have the opportunity to attract clients who prefer dealing with

Table 3. Efficiency of Saudi Arabia's Takaful and insurance companies, 2014–2017

Code	2014	2015	2016	2017	Average	Rank
Conventional Companies						
1	0.4186	0.5528	0.4338	0.0996	0.3762	18
2	0.2685	0.3696	0.1303	0.0945	0.215,725	31
3	0.3729	0.4265	0.1852	0.2243	0.302,225	25
4	0.1898	0.0756	0.2075	0.1006	0.143,375	33
5	0.5921	0.5185	0.523	0.6033	0.559,225	12
6	0.4229	0.34	0.3407	0.3823	0.371,475	19
7	0.625	0.4296	0.4564	0.1915	0.425,625	17
8	0.4341	0.7201	0.5533	0.2112	0.479,675	16
9	0.4932	0.8836	0.5772	0.4556	0.6024	7
10	0.8637	1	0.9438	0.6616	0.867,275	1
11	0.5043	0.3459	0.2957	0.2396	0.346,375	22
12	0.3523	0.3235	0.2577	0.0825	0.254	28
13	0.3439	0.2773	0.179	0.1086	0.2272	29
14	0.3761	0.2493	0.3917	0.2237	0.3102	23
15	0.4649	0.6721	0.6981	0.773	0.652,025	5
16	0.381	0.2567	0.5779	0.2646	0.37,005	20
17	0.6758	0.7038	0.5232	0.4368	0.5849	9
18	0.1843	0.2515	0.4481	0.2054	0.272,325	26
19	0.6345	0.4619	0.5316	0.6937	0.580,425	10
20	0.2855	0.4069	0.1968	0.1736	0.2657	27
21	0.462	0.4791	0.8293	0.8673	0.659,425	4
22	0.6608	0.6823	0.6077	0.7635	0.678,575	3
23	0.8312	0.5452	0.5149	0.4288	0.580,025	11
24	0.5359	0.5277	0.0847	0.0856	0.308,475	24
25	0.483	0.6349	0.6251	0.2464	0.49,735	15
26	0.4391	0.4341	0.3383	0.2398	0.362,825	21
Average	0.4729	0.48,340	0.44,042	0.34,066	0.43,434	
Takaful Companies						
27	0.743	0.6065	0.7038	0.8082	0.715,375	2
28	0.3373	0.237	0.2359	0.0818	0.223	30
29	0.6559	0.665	1	0.0509	0.59,295	8
30	0.468	0.5832	0.5211	0.4318	0.501,025	14
31	1	0.6223	0.7451	0.0825	0.612,475	6
32	0.7499	0.43	0.3928	0.5244	0.524,275	13
33	0.2555	0.2875	0.1706	0.0982	0.20,295	32
Average	0.60,137	0.490,214	0.53,847	0.29,682	0.48,172	
Overall Average	0.49,935	0.484,806	0.46,060	0.33,164	0.4441	

insurance companies that operate in harmony with Shari'ah principles. Second, the average efficiency for all the insurance firms declines during 2014–2017. Third, about 21% of the firms (6% Takaful firms and 15% conventional insurance firms) are able to maintain their competitive level at an average efficiency score of 0.60 per year. This can be attributed to the decrease in overall economic growth and low interest rates in the country caused by a sharp decline in oil prices in the global market owing to the global financial crisis. In addition, SAMA's new regulation

stipulating the “Saudization” of all insurance companies’ administrative and non-administrative functions plays a critical role. The lack of Saudi experts in the actuarial sector could be another reason contributing to the decreasing efficiency scores. Saudi Arabia’s insurance market is highly fragmented with small firms competing against each other, which hinders the sustainability of the industry. Finally, lower efficiency may be caused by the low levels of penetration and insurance density in the previous years, which in turn, limit insurance revenue. Such firms find it difficult to follow SAMA’s new regulations and requirements such as technical underwriting, reserving, and solvency (Akhtar, 2018).

Tables 4 and 5 summarize the results for the leader stage identification. The second and third columns highlight the upper and lower bounds for the stage-one efficiency of $DMU_j(e_j^{1,U}, e_j^{1,L}), j = 1, 2, \dots, 33$; the fourth and fifth columns present the lower and upper bounds for the stage-two efficiency of $DMU_j(e_j^{2,L}, e_j^{2,U}), j = 1, 2, \dots, 33$; and the last column reveals the dominant stage. For Takaful firms, the operational stage (stage one) is the dominant stage for three firms during 2014–2015 and four firms in 2016; on the other hand, the investment stage (stage two) is the dominant stage for four firms between 2014 and 2015 and three firms in 2016. For conventional insurance firms, the operational stage (stage one) is the leader stage for 17, 20, and 16 firms in 2014, 2015, and 2016, respectively. By contrast, the investment stage (stage two) is the leader stage for 9, 6, and 10 firms in 2014, 2015, and 2016, respectively. In 2017, the investment stage is the leader stage for all Takaful firms and 18 conventional insurance firms, indicating stage-two dominance. It is noteworthy that Takaful and conventional insurance firms that report investment as the dominant stage perform better in 2017. Thus, the dominant investment stage in 2017 for both Takaful and conventional insurance firms could define the efficiency level and accordingly, the input and reserve requirements for the operational stage. However, this is not the case for the years 2014–2016. Consequently, it is necessary to identify the leader stage for each Takaful and conventional insurance firm to gain information on internal decision-making processes, which is occasionally overlooked by decision makers. This approach will help manager and regulators adjust and improve overall efficiency by optimizing the leader stage.

5. Conclusions

This study aims to analyse Takaful and conventional insurance firms in Saudi Arabia’s insurance industry during 2014–2017. To the best of the author’s knowledge, this study is the first to use a two-stage DEA (Despotis et al., 2016) to assess the efficiency of the two sub-stages of production with focus on Takaful and conventional industry. In addition, it applies Li et al.’s (2018) extended method to identify whether the operational or profitability stage is the leader stage.

The study offers the following conclusions for the sample period. First, the average efficiency scores for both Takaful and conventional insurance firms have monotonically decreased. Second, a possible solution to low efficiency levels is enhancing the consolidation and foreign participation regulations for the insurance industry so that firms can become dynamic and remain competitive in Saudi Arabia’s crowded market. Third, even though Takaful insurance firms perform better than conventional insurance firms in terms of average efficiency scores, there remains scope for improvement in terms of overall efficiency and productivity. Fourth, managers and regulators should take advantage of Takaful/Shari’ah products designed on the basis of the Islam principles of general cooperation and solidarity. Finally, the empirical analysis to identify the leader stage for both Takaful and conventional insurance firms elucidates that optimizing the leader stage is necessary to enhance the balance between the two stages.

This study can assist regulators and managers attempting to improve and develop the overall performance of Saudi Arabia’s insurance industry. Further, the empirical results and their implications will help SAMA design clear regulations for a highly competitive environment. Nevertheless, further comprehensive studies are needed given that the insurance sector will be among the major gainers and is among the focus areas of Saudi Vision 2030.

Table 4. Leader stage identification results for 33 insurance companies in Saudi Arabia, 2014 and 2015

DMU	2014						2015					
	$e^{1,U}$	$e^{1,L}$	$e^{2,L}$	$e^{2,U}$	Leader Stage		$e^{1,U}$	$e^{1,L}$	$e^{2,L}$	$e^{2,U}$	Leader Stage	
1	0.9247	0.3782	0.857	0.4936	1		0.8939	0.6169	0.8895	0.6227	1	
2	0.3693	0.7275	0.3677	0.7302	2		0.699	0.5323	0.6219	0.5892	1	
3	0.3858	0.9659	0.3787	0.985	2		0.5263	0.7917	0.4999	0.8605	2	
4	0.639	0.2423	0.4904	0.3917	1		0.9068	0	0.3631	0.2205	1	
5	1	0.5921	1	0.5921	1		1	0.5185	1	0.5185	1	
6	0.4229	1	0.4229	1	2		0.6329	0.5416	0.5867	0.5487	1	
7	1	0.625	1	0.625	1		0.7729	0.2609	0.6995	0.6661	1	
8	0.8935	0.4529	0.7379	0.5812	1		0.9101	0.2843	0.7838	1	1	
9	0.617	0.7999	0.5681	0.8667	2		1	0.8836	1	0.8836	1	
10	1	0.8637	1	0.8637	1		1	1	1	1	1	
11	0.7071	0.7188	0.673	0.7296	2		0.4817	0.7306	0.443	0.7561	2	
12	1	0.3461	0.8353	0.41	1		0.77	0.3196	0.6715	0.4443	1	
13	0.8068	0.3054	0.6772	0.4988	1		0.5879	0.4718	0.5879	0.4718	1	
14	0.7018	0.4784	0.6204	0.5847	1		0.8624	0	0.5814	0.5296	1	
15	0.6598	0.7046	0.5946	0.7571	2		0.7173	0.9088	0.6963	0.9695	2	
16	1	0.381	1	0.381	1		1	0.2567	1	0.2567	1	
17	1	0.6758	1	0.6758	1		1	0.7038	1	0.7038	1	
18	0.1862	0.989	0.1843	1	2		0.6348	0.3688	0.6259	0.4076	1	
19	1	0.6365	0.9417	0.6401	1		0.8685	0.5113	0.8654	0.5363	1	
20	0.3015	0.9408	0.3005	0.9506	2		0.6205	0.6058	0.6058	0.6784	2	
21	0.6014	0.7645	0.5605	0.8087	2		0.6315	0.7769	0.5528	0.8435	2	
22	0.9109	0.6821	0.9021	0.7393	1		0.7539	0.8162	0.7511	0.9104	2	
23	1	0.8312	1	0.8312	1		1	0.3231	0.8198	0.7329	1	

(Continued)

Table 4. (Continued)

DMU	2014						2015					
	$e^{1,U}$	$e^{1,L}$	$e^{2,L}$	$e^{2,U}$	Leader Stage		$e^{1,U}$	$e^{1,L}$	$e^{2,L}$	$e^{2,U}$	Leader Stage	
24	0.8847	0.4719	0.8538	0.6481	1		0.9219	0.5303	0.8933	0.6054	1	
25	1	0.483	1	0.483	1		1	0.6349	1	0.6349	1	
26	1	0.4401	0.9291	0.4702	1		1	0.4341	1	0.4341	1	
27	0.8181	0.9104	0.8073	0.9166	2		0.6065	1	0.6065	1	2	
28	1	0.3373	1	0.3373	1		1	0.2397	0.5718	0.252	1	
29	0.6559	1	0.6559	1	2		0.7875	0.8857	0.5997	1	2	
30	0.6489	0.6927	0.6208	0.7527	2		0.8098	0.6877	0.7778	0.7617	1	
31	1	1	1	1	1		1	0.6223	1	0.6223	1	
32	0.9804	0.7767	0.8598	0.8517	1		0.4843	0.8576	0.4568	0.9455	2	
33	0.2797	0.9062	0.2703	0.9471	2		0.4268	0.69	0.3713	0.7605	2	

Note: The rows highlighted in grey refer to Takaful firms.

Table 5. Leader stage identification results for 33 insurance companies in Saudi Arabia, 2016 and 2017

DMU	2016						2017					
	$e^{1,U}$	$e^{1,L}$	$e^{2,L}$	$e^{2,U}$	Leader Stage		$e^{1,U}$	$e^{1,L}$	$e^{2,L}$	$e^{2,U}$	Leader Stage	
1	0.8352	0.5237	0.7471	0.5327	1		0.2651	0.3326	0.2019	0.4663	2	
2	0.2486	0.5662	0.1706	0.66	2		0.1566	0.4844	0.1491	0.6395	2	
3	0.3593	0.5467	0.2325	0.7256	2		0.3342	0.5467	0.3084	0.7382	2	
4	0.4085	0.2567	0.4076	0.51	1		0.3096	0.3075	0.2081	0.3831	2	
5	1	0.5083	0.8765	0.5957	1		1	0.6033	1	0.6033	2	
6	0.3821	0	0.3505	1	2		0.4827	0.6976	0.3909	1	2	
7	0.6571	0.6976	0.6397	0.7081	2		0.2979	0.5745	0.2854	0.6783	2	
8	0.9925	0.5549	0.9881	0.5616	1		0.4781	0.3927	0.3707	0.5502	2	
9	0.7663	0.6121	0.7085	0.84	1		0.5644	0.6121	0.5445	0.8517	2	
10	1	0.939	0.8952	1	2		0.7624	0.6681	0.6763	1	2	
11	0.5091	0.6084	0.3395	0.8267	2		0.2958	0.6084	0.2827	0.858	2	
12	0.6353	0.402	0.6353	0.4057	1		0.2752	0.2446	0.245	0.3436	2	
13	0.3654	0.49	0.3654	0.49	2		0.3746	0	0.2164	0.4202	1	
14	1	0.3917	1	0.3917	1		0.7238	0.2946	0.4486	0.3917	1	
15	0.8906	0.7839	0.8906	0.7839	1		1	0.773	1	0.773	1	
16	0.9897	0.5757	0.9114	0.6164	1		0.4636	0.5163	0.4461	0.6025	2	
17	0.6533	0.8008	0.6533	0.8008	2		0.656	0.5948	0.545	0.7894	2	
18	0.849	0.506	0.1973	0.7319	2		0.3708	0.429	0.0779	0.6828	2	
19	0.8665	0.5543	0.7787	0.7073	1		1	0.6937	1	0.6937	1	
20	0.3641	0.5277	0.2818	0.6468	2		0.243	0.6783	0.2312	0.7564	2	
21	1	0.8293	1	0.8293	1		1	0.8673	1	0.8673	1	
22	0.7859	0.7624	0.7806	0.7815	1		1	0.7635	1	0.7635	1	
23	0.7744	0.5846	0.6944	0.7593	1		0.5624	0.5846	0.558	0.7724	2	

(Continued)

Table 5. (Continued)

DMU	2016						2017					
	$e^{1,U}$	$e^{1,L}$	$e^{2,L}$	$e^{2,U}$	Leader Stage		$e^{1,U}$	$e^{1,L}$	$e^{2,L}$	$e^{2,U}$	Leader Stage	
24	0.9547	0	0.6931	0.2216	1		0.6012	0	0.4054	0.2216	1	
25	1	0.6237	0.9395	0.6674	1		0.4133	0.4838	0.3873	0.6481	2	
26	1	0.3383	1	0.3383	1		1	0.2296	0.5685	0.3383	1	
27	0.8518	0.8784	0.6313	1	2		0.8932	0.8608	0.8262	1	2	
28	1	0.2393	0.4508	0.2549	1		0.3258	0.2504	0.0767	0.3229	2	
29	1	1	1	1	1		0.0509	1	0.0509	1	2	
30	0.812	0.5525	0.6256	0.7642	1		0.6231	0.5525	0.5517	0.7996	2	
31	1	0.7451	1	0.7451	1		0.1294	0.5419	0.1286	0.6422	2	
32	0.6876	0.6057	0.3448	0.8684	2		0.6742	0.6057	0.6119	0.8736	2	
33	0.2225	0.7952	0.1692	1	2		0.1026	0.7952	0.0985	1	2	

Note: The rows highlighted in grey refer to Takaful firms.

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Note

1. The Gulf Cooperation Council (GCC) member states include Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates.

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Appendix I

Table A1. List of Saudi Arabia's Takaful and conventional insurance Companies in the sample

Number of DMUs	Company Name
	Conventional Insurance Companies
1	Al Alamiya for Cooperative Insurance Company
2	Al Sagr Co-operative Insurance Cooperative
3	Al-Ahlia Insurance Company
4	Alinma Tokio Marine Company
5	Allianz Saudi Fransi Cooperative Insurance Company
6	Amana Cooperative Insurance Company
7	Arabia Insurance Cooperative Company
8	Arabian Shield Cooperative Insurance Company
9	AXA Cooperative Insurance Company
10	Bupa Arabia for Cooperative Insurance
11	Buruj Cooperative Insurance Company
12	Chubb Arabia Cooperative Insurance Company (Chubb)
13	Gulf General Cooperative Insurance Company
14	Gulf Union Cooperative Insurance Company
15	Malath Cooperative Insurance and Reinsurance Company
16	MetLife, American International Group and Arab National Bank Cooperative Insurance Company.
17	Saudi Arabian Cooperative Insurance Company
18	Saudi Enaya Cooperative Insurance Company
19	Saudi Indian Company for Cooperative Insurance
20	Saudi Re for Cooperative Reinsurance Company
21	Company for Cooperative Insurance (Tawuniya)
22	Mediterranean and Gulf Cooperative Insurance and Reinsurance Company
23	Trade Union Cooperative Insurance Company
24	United Cooperative Assurance Company
25	Walaa Cooperative Insurance Company
26	Wataniya Insurance Company
	Takaful Insurance Companies
27	Al-Rajhi Company for Cooperative Insurance
28	AlAhli Takaful Company
29	Aljazira Takaful Taawuni Company
30	Allied Cooperative Insurance Group
31	SABB Takaful Company
32	Salama Cooperative Insurance Company
33	Solidarity Saudi Takaful Company



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