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Article

Measuring the relative efficiency of insurance companies in Saudi Arabia: The case study of Takaful vs cooperative industries

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GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

Measuring the relative efficiency of insurance companies in Saudi Arabia: The case study of Takaful vs cooperative industries

Slah Benyoussef¹ and Wael Hemrit^{1*}

Abstract: The aim of this paper is to measure the efficiency of insurance companies in Saudi Arabia using data envelopment analysis (DEA), to analyse the effectiveness of underwriting processes primarily inputs and outputs are determined. Moreover, this study aims at comparing the efficiency of Takaful and cooperative *in the year 2014*. Taking into account two main approaches of this technique and considering a sample of 23 insurance companies, we show that the results revealed that insurance companies do not operate efficiently. Also, a classification of companies allows to discover that on average, Takaful insurance are relatively more efficient than cooperative insurance companies. The main finding of this paper is the need for better resource allocation in the cooperative insurance companies' systems, because some Takaful insurance companies have resource surplus and in other cooperative ones it is observed a lack of resources.

ABOUT THE AUTHORS

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PUBLIC INTEREST STATEMENT

We have analysed the relative technical efficiency in a representative sample of Saudi Arabian insurance companies under Takaful and cooperative principles for the year 2014, a period of decent growth despite significant ascend in loss adjustment expenses from catastrophes and underwriting results. This contribution is based on the most popular method for efficiency called Data Envelopment Approach that allows for the incorporation of various inputs and outputs in determining relative efficiencies. The main finding of this paper is the need for better resource allocation in the cooperative insurance companies' systems. Some Takaful insurance companies have resource surplus and have all the room to grow as driven by the expansion in underwriting capacity in the segment with mounting awareness of Shari'ah compliant concept and practices. The major policy implication of this research is that minor differences between Takaful and cooperative-mutual practices increase the efficiency of the units operating in the protected market in which the ethical business is in total compliance with Shari'ah principle.

Subjects: Middle East Studies; Economics and Development; Finance; Business, Management and Accounting; Industry & Industrial Studies

Keywords: efficiency; DEA; inputs and outputs; insurance; takaful; Saudi Arabia

1. Introduction

Saudi Arabia has become one of Gulf Arab economic success stories in recent years with average economic growth of 5.18%. After a flow in prosperity over the past decade characterized by rising price of fuel linked to higher oil costs, Saudi Arabia's economy is at a transition point. The Saudi Arabia's insurance companies turn into truly multichannel and has become integral to accept fundamental changes, despite mandatory legacy schemes. The growth of Saudi insurance market decelerated for the first time in last decade, posting 0.5% versus 20% in the prior year.

Despite a relatively rapid implementation and modest improvements in insurance coverage quality as assessed by process measures, the Saudi Arabia insurance sector has witnessed major growth with the support of the improvement in the regulatory environment and the enforcement of the compulsory insurance. Many insurance companies in the Saudi Arabia do operate in strict accordance with the Takaful model, being seen as connecting several acts prohibited under sharia, including *riba* (usury), *gharar* (uncertainty) and *maisir* (gambling). Saudi Arabia insurance companies operate in a challenging environment in which many organisations as well as many policyholders and investors have very limited understanding the role of the insurance industry in sustainable development.

In this regard, efficiency at the unit level has become a major current economic issue that financial sector is facing today, due the fast extension of insurance activities that has come at a price. An increasingly teeming market has ensued eventually push up premiums price and led to more intense competition, which reached a level that had a detrimental effect on the operational profit posted by many participants (Mirah & Masa'deh, 2014; Saudi Arabian Monetary Authority—SAMA, 2015).²

Therefore, it is necessary for insurance regulators and market analysts to have relevant conclusion about Takaful insurance industry efficiency that helps to identify the production processes that engender multiple outputs. Within the increasing developments of the Islamic insurance system, an examination of the efficiency of Takaful insurance is further implicated in motivation, as the alternative accounting-based financial ratio measures of insurance industry performance is very limited and the importance of the operational and strategic decision-making (Abdul Kader et al, 2010). Such study can operate as feedback loops to develop the competitiveness and efficiency of insurance systems. If there is significant inefficiency and a lack of comprehensive regulation within an overall outdated system, there may be room for adjustment and restructuring activities in response to increasing competition to improve the efficiency of the insurance system (Brockett, Cooper, Golden, Rousseau, & Wang, 2004; Cummins, Weiss, Xie, & Zi, 2010; Ertugrul, Oztas, Ozcil, & Oztas, 2016; Fenn, Vencappa, Diacon, Klumpes, & O'Brien, 2008).

In Art.1 of the General Principles of the Statute of Governance Law in the Kingdom of Saudi Arabia, insurance companies in Saudi Arabia adopt the cooperative and Takaful system as a basis for its work in accordance with the principles of Islamic *Sharia* and *Fiqh*. All these contracts are based on the principles of voluntary contribution (*tabarru'*) and mutual cooperation which include cooperative and Takaful insurance under the title of contributions. But despite the seeming similarity, it is meaningful to distinguish between cooperative and Takaful insurance; The cooperative insurance is practised by a social organization without capital stock (or associations with mutual form) which provides insurance to its members on an assessment basis. Members of this association pool their risks that are to be insured and make contributions to the risk pool so that valid claims may be paid (Archer & Abdel Karim, 2007). The purpose of this system is not profit but

to uphold the principle of “We jointly bear the risk.” For the Takaful insurance, practice insurance operations on the basis of Islamic Takaful Insurance refer to the hybrid model. On the one hand, there is a shareholding company on which the shareholders seek to realize a profit and returns on their investment. On the other hand, there are participants (*Mushtarik*) who pay contributions (*Ishtirak*) to the community takaful fund that lead to the formation of the “subscriber fund”. The subscribers’ fund is supposed to pay the compensation due to the subscribers. In cases where there are insufficient funds in the pool, the shareholders’ fund is required to provide a loan (*qard al hassan*). Under the Sharia environment, the loan was granted and has to be repaid, regardless to duration (Gönülal, 2013). While the market for sector insurance in Saudi Arabia started with only one company in 2004, it currently involves about 4 Takaful and 19 cooperative insurance companies.

As shown in Table 1, the Saudi Arabian insurance industry was revealing under the positive economic momentum caused by the regulatory changes and premium growth in the automobile and healthcare business lines. The insurance sector in Saudi Arabia has witnessed good traction coming from the improvement in the regulatory environment, but its growth decelerates for the last five years posting 0.5% versus 20% in the first decade of twenty-first Century.

To the extent that the contribution of these insurance business lines to the GDP displayed an annual compound growth rate of 16.4% during the period between 2011 and 2014, the Protection and Security P&S insurance segment has made a lower contribution to GDP growth in Saudi Arabia compared with that witnessed in the rest of the world. Moreover, in the first years, the Gross Written Premium GWP saw a significant drop, but over the past two years, the GWP has seen a decline, and as these falls below the steady growth line for all business lines.

The result can be explained by the decrease in oil price which leads to a higher-than-forecasted fiscal deficit and a decline in the purchasing-power-parity adjusted per capita during this period.³ Furthermore, the decrease of the retention ratio in the vehicle insurance is due to the increase of the cost of providing coverage and the technical reserves. This deterioration in the underlying retention ratio reflects the higher loss ratio reported for the year, but the results still reflect a solid financial performance considering the market conditions.⁴

The slight variation in the P&S insurance line is mainly due to the complexity of the Muslim’s life aspects and the practical rules of the Sharia that considers P&S insurance contract to be haram because it distrusts in Allah’s foresight and does not take into consideration that every person having to die per divine decree. This is reflected in the retention which is low compared to other business lines, but each insurance company will anticipate having high growth or opportunities to expand its business. The claim ratio continues not to exceed 50% on all years. This indicates that the sector is making underwriting profit and the collecting premiums are higher than the amount paid in claims.

The health insurance still the dominant business line given that the council of cooperative health insurance regulations began enforcing the compulsory health insurance system under many forms (Hospitalization and outpatient treatment, dental and optical care) for non-Saudi workers and all the families of residents who are working in the private sector in late 2010. This is reflected in the number of accredited health providers composed of a large majority of pharmacies and medical centres and their number reached 2130 and 1055, respectively, by the end of 2016. Over the past five years, this business line increased to about 1.01% in 2016 from 0.44% in 2011. Government’s policy of health has gradually pushed insurance penetration in the Saudi Arabia and proliferation of insurance schemes are expected to introduce a comprehensive, fair, and affordable service for the whole population.

The legislative changes affecting the process for seeking premium admits the average increase for vehicle insurance premiums following the Government’s assessment of requests from vehicle

insurers. In 2016, the vehicle business line reported an increase of annual gross written premium at rates equal to 20.8% that is higher than the general rate in spite of continued tough underwriting conditions. Hence, more than 0.8% of Saudi Arabia's gross domestic product (GDP) was accounted for by vehicle insurance premiums in 2016, making it the country with the first-highest insurance penetration in the Arab world. Even with the increase looming, the claim cost remains considerably. The retention ratio is very high reflecting that the health and vehicle insurance might have the ability to take on more risk or a higher retention level. For that matter, in 2016, the claim ratio of the health and vehicle insurance stand at 97% and 83%, respectively. This high ratio gives clear and practical recommendations such as requiring companies to adjust the amount of future premiums in renewing the terms and conditions of the policy which is normally increase in premium.

Most of studies have attempted to measure the efficiency of conventional insurance, but a few studies have also focused on the efficiency of Islamic insurance companies (Ismail, Alhabshi, & Bacha, 2011; Abdul Kader et al, 2010; Khan & Noreen, 2014; Al-Amri, 2015; Antonio et al, 2013). There is no systematic empirical research exists addressing the question of how Takaful formula shapes the overall level of efficiency and gives an indication of the similarity and difference between Takaful and cooperative insurance efficiency. Moreover, in spite of many dramatic changes in Saudi Arabia insurance market, it is worth noting that there are few studies that focus on the efficiency of Saudi Arabian insurance market (Ben Jedidia & Medhioub, 2015) despite it has emerged as one of the most important cooperative finance components that contribute towards the overall development of the national economy. This is particularly true for the Takaful insurance market, where some of the more dynamic changes in market structure have been taking place not only in the Saudi Arabia, but also in the countries where financial institutions work far from a blacklist of prohibited investments established by the *Sharia* tenets.

We contribute to this empirical literature by using an extensive panel data set of 23 Saudi Arabia insurance companies during 2014. Throughout this year, the insurance sector in Saudi Arabia registered decent growth despite significant ascend in loss adjustment expenses from catastrophes and underwriting results. The Saudi Arabian Monetary Agency (SAMA) suggested that this year's results show extremely strong growth of the insurance market in Saudi Arabia, as a result of corrective and preventive actions taken during the past year. These measures included strengthening the required technical reserves to comply with regulatory regulations and instructions, in line with the recommendations of the actuaries appointed by the Saudi Arabian insurance companies. Moreover, these control measures were implemented to enhance the technical controls of the underwriting process, which contributed to the positive results of underwriting (operating profits), which amounted over to about SR 651 million compared to a loss of SR 1,725 million during the previous years. This lead to an increase in the company's profit of SR 735 million during the year 2014 compared to a loss of SR 1,428 million during the previous year. This is due to the market recovering from undesirable underwriting consequences in some previous years (when it was influenced by high competition, lower interest rate and high inflation environment).

Such a large sample and relatively a period in which many business lines appear to be characterized by hard market, in which prices rise rapidly and a greater reliance on competition among insurers, allow us to capture the changes over the enormous challenges in broadening the economic base. One of the major research areas in financial institutions is the measurement of the relative efficiency by means of popular non-parametric techniques such as Data Envelopment Analysis DEA (Hemmati, Dalghandi, & Nazari, 2013).

Table 2 recapitulates earlier DEA-based studies on insurance efficiency analysis, by presenting their main characteristics regarding the inputs and outputs used, the number of DMUs considered, and their country of origin, the type of data used (cross-section or longitudinal), and methodological approach.

Table 1. Gross written premium growth by line of business (2011–2016)

	GWP growth (%)					
	2011	2012	2013	2014	2015	2016
Health. Ins.	14.2	16.2	14.2	21.9	20.6	20.25
Vehicle. Ins	17.3	19.5	35.5	26.3	34.5	20.8
P&S Ins.	-0.09	-0.01	-0.05	07.0	14.5	12.0
	Retention ratio by line of business (2011 to 2016).					
Health. Ins.	0.847	0.882	0.888	0.932	0.959	0.970
Vehicle. Ins	0.946	0.940	0.939	0.947	0.918	0.874
P&S Ins.	0.929	0.863	0.845	0.807	0.806	0.818
	Claims ratio by line of business (2011 to 2016).					
Health. Ins.	0.718	0.776	0.929	0.815	0.795	0.970
Vehicle. Ins	0.735	0.786	0.971	0.798	0.902	0.831
P&S Ins.	0.347	0.246	0.416	0.451	0.466	0.425

The objective of our study is twofold. First, we analyse insurance efficiency in Saudi Arabia by applying the non-parametric method in operations research and economic introduced by (Charnes, Cooper, Lewin, & Seiford, 1994). This method allows to stem the relative efficiency of production units using linear programming (Heidari, Omid, & Akram, 2011). Second, we provide a detailed analysis that enables us to obtain more reliable evidence for Takaful compared to cooperative insurance efficiency. The results also show that the Saudi Arabian insurance industry operated fairly efficiently during the period examined (the year 2014). In addition, the relative scale efficiency in the Saudi Arabian insurance industry is found in this study.

The remainder of the paper is organized as follows: Section 2 discusses the DEA methodology used, the data source and the model; results are examined and presented in Section 3; and Section 4 sets out the conclusion.

2. Methodology

Empirical research on financial institutions efficiency in transition economies has been intensive in recent years. The insurance sector in particular has seen rapid growth in the way of risk multiplication factors in the number of studies applying Data Envelopment Analysis (Cummins & Rubio-Misas, 2006; Khan & Noreen, 2014; Luhn, 2009). As the earlier list of applications suggests, DEA can be a powerful tool when used wisely. This nonparametric linear programming-based technique has been used in the examination of major economic problem in advanced economies, such as comparing the efficiency of insurance companies sited in different countries. It estimates the maximum potential output for a given set of weighted output/inputs, that has primarily been used in the estimation of efficiency frontier (Charne et al, 1978).

There are several key advantages to choosing a DEA over other approaches previously examined is that it more easily handles multiple input and multiple output models and does not require an assumption of a functional form relating inputs to outputs (as is required in the use of the Stochastic Production Frontiers approach). Moreover, Decision Making Units (DMUs) are directly compared against a peer or combination of peers (Molyneux & Vallelado, 2008). Cummins et al. (2010) suggest that DEA estimators are unbiased if there is no underlying model or reference technology. However, the DEA has some limitations and/or disadvantages such as imperfect competition in insurance sector and regulation constraints that may cause a DMUs not to be operating at optimal scale. First, Molyneux and Vallelado (2008) show that this methodology cannot be used to conduct conventional statistical tests of hypotheses because of the presence of the noise error. Second, Luhn (2009) stipulates that there seems to be widespread

Table 2. DEA-based studies on insurance companies' efficiency

Authors	Methodology	Sample size	Inputs	Outputs	Year(s)	Country/ Region
Eling & Schaper (2017)	Multi-stage DEA	970	Number of employees, debt capital, equity capital	Losses plus additions to reserves, total invested assets	2002–2013	14 European countries
Wanke & Barros (2016)	The two-stage DEA meta frontier-data mining approach	1843	Current Assets, Real Assets, Long Term Fixed Assets and other Long-Term Assets	Direct Premium, Insurance Premium, Retained Premium and Earned Premium	1995–2013	Brazil
Ertugrul et al. (2016)	DEA approach	70	Labor expenses, equity capital and debt capital	Insurance technical provisions and losses paid	2010–2014	Turkey
Al-Amri (2015)	DEA approach	115	Labor, Debt capital and Equity capital	Losses incurred and investments	2004–2009	GCC countries
Khan & Noreen (2014)	DEA approach	17	Labor, fixed assets, business services and equity capital	Invested assets, net premium	2006–2010	Pakistan
Antonio, Ali, & Akbar (2013)	DEA approach	73	Management expenses, fees and commission expenses	Gross premium and investment income.	2009–2011	Malaysia
Ismail et al. (2011)	DEA approach	666	Labor, business services and materials, and equity capital	Real incurred losses, and the real value of investments	2007–2011	13 countries
Cummins et al. (2010)	DEA approach and multiple regression analysis	4546 life & H Ins. 10057 P&L Ins.	Labor, business services and equity capital	Individual annuities, Group annuities, Personal (Commercial) short and long tail	1993–2006	U.S.A
Eling & Luhnen (2009)	DEA approach	3831	Labor and business service, Debt capital, Equity capital.	Non-life claims + additions to reserves, Life benefits + additions to reserves, Investments.	2002–2006	36 countries
Davutyan and Klumpes (2008)	DEA approach	472	business services, labour, and equity capital	The actuarial, underwriting and related expenses, Real financial services, The net interest margin	1996–2002	7 countries

disagreement with regard to appropriate input factors in insurance field. According to Trick (2008), this method is appropriate at estimating “relative” efficiency of a DMU, but it converges very slowly to “absolute” efficiency. Third, Bi, Feng, Ding, and Khan (2012) indicate that the DEA models treat a DMU as a “black box”, which is often criticized for not considering the inner structure and with the network models, there is a missing of inner data in parallel production settings. In conclusion, the main advantage of this method still the flexibility due to its non-parametric nature, i.e. no assumption about the production function is required. For this reason, because efficiency is measured as the distance to this frontier, without considering statistical noise, DEA is the deterministic model (Andor & Hesse, 2011, p. 1).

2.1. Data collection and sources

The players in Saudi insurance industry consists of Takaful and cooperative insurers (composite and life) constituted in and outside Saudi Arabia. Based on the Annual Insurance Report and Annual Takaful Report from Saudi Arabian Monetary Authority SAMA during 2014, there are 36 players that consistently remain in the industry.

The global insurance industry continues to grow rapidly, but consistent and robust profitability is elusive. However, for the purpose of this study, the selection of the companies is restricted to the top 23 largest auto insurance companies ranked by market share, with customer satisfaction ratings and links to reviews (19 cooperative insurers and 4 Takaful insurance) (SAMA, 2014). The data are segregated between the two business lines (general and life) and can be obtained from the companies’ financial report. The firms under observation according to the type of business are depicted in Table 3.

2.2. Selections of inputs and outputs

There is extensive agreement in the literature with regard to the determination of inputs and outputs that are decisive in insurance industries (Abduh, Raudhoh, & Omar, 2012; Cummins, Rubio-Misas, & Zi, 2004; Eling & Luhn, 2009). In general, inputs such as capital and gross premiums represent the resources that are exploited to generate the insurance’s output. Capital inputs are fragmented between shareholders’ capital and reserves, technical provisions, and debt—all measured at the start of the financial year. Outputs, on the other hand, represent firstly, the issues payment to the insured or an approved interested party on behalf of the insured and secondly, the investment that has substantial value-added, as judged by operating cost allocations (Berger & Humphrey, 1992).

Besides that, capital and gross premiums are taken as input, while claims and investment income are taken as output and this is in line with what has been done by Diacon, Starkey, and O’Brien (2002).

The datasets generated during and/or analysed during the current study allow us to simplify this scheme by combining administrative expenses, commissions and reinsurance cost as only gross premium. This approach is a common practice that many studies have been focused on international efficiency comparisons (see Diacon, Starkey and O’Brien, 2002; Eling. & Luhn, 2009), usually for motives analogous to ours.

A summary of inputs and outputs is provided in Table 4 for 2014. All values have been converted into U.S.\$ million at year-end exchange rates. The high standard deviation of investments (67.3 U.S.\$ million), claims (74 U.S.\$ million) and capital (76 U.S.\$ million), which indicates the extent to which the financial situations of insurance companies are spread out over a wider range of the values. In the financial field, the larger the investment’s standard deviation, the more dispersed those insurance returns are and thus the riskier the investment is. Moreover, a margin for adverse deviations of insurance claims reflects the degree of uncertainty of the best loss estimate approach.

Table 3. List companies of the empirical study

No	Symbol	Company Name
1	8290	Solidarity Saudi Takaful Co.
2	8220	Weqaya Takaful Insurance and Reinsurance Co.
3	8140	Al-Ahlia Insurance Co.
4	8080	SABB Takaful Co.
5	8170	Trade Union Cooperative Insurance Co.
6	8190	United Cooperative Assurance Co.
7	8300	Wataniya Insurance Co.
8	8200	Saudi Re for Cooperative Reinsurance Co.
9	8110	Saudi Indian Company for Cooperative Insurance
10	8010	The Company for Cooperative Insurance
11	8030	The Mediterranean and Gulf Insurance and Reinsurance Co.
12	8270	Buruj Cooperative Insurance Co.
13	8260	Gulf General Cooperative Insurance Co.
14	8120	Gulf Union Cooperative Insurance Co.
15	8150	Allied Cooperative Insurance Group
16	8310	Amana Cooperative Insurance Co.
17	8160	Arabia Insurance Cooperative Co.
18	8280	Al Alamiya for Cooperative Insurance Co.
19	8180	Al Sagr Cooperative Insurance Co.
20	8070	Arabian Shield Cooperative Insurance Co.
21	8250	AXA Cooperative Insurance Co.
22	8210	Bupa Arabia for Cooperative Insurance Co.
23	8230	Al-Rajhi Company for Cooperative Insurance

This table also revealed that takaful operators exhibit a relatively high inputs and outputs than cooperative insurers. In a while, the takaful fund is a separate fund that does not belong to the Takaful operator. Consequently, takaful funds would boost investments and capital, given that the shareholders are allowed to share in the surplus of takaful funds or to share in the profit from their investment activities.

2.3. Data envelopment analysis and model specification

We focus on the most appropriate category of benchmarking techniques called frontier efficiency that defines the “best practices” of the most efficient companies and assimilates all inputs and outputs into a single performance measure. DEA is considered as a nonparametric method that suppose a no random mistakes and can readily incorporate multiple inputs and outputs to calculate technical efficiency. Efficient firms are those that produce a certain amount of outputs using a given amount of inputs or use the same amount of or less inputs to produce a given amount of outputs, as compared with other firms in the test group.

To differentiate between insurance companies displayed at the national framework (Cooper, Seiford, & Zhu, 2004), we use DEA to estimate “best practice” efficiency scores. Efficiency scores can be employed in different ways to provide managerial insight into how maintain the efficiency index for all DMUs (Vincová, 2005).

The specifications proposed by Charnes et al. (1978) address the developing measures of technical efficiency merging with scale efficiency with special reference to possible use in evaluating public programs. Thus, we shall also want to free ourselves from this hypothesis by opting for an extension

Table 4. Summary statistics for variables used (U.S.\$ million)

Variable	Obs			Mean			Std. Dev			Minimum			Maximum		
	T	C	O	T	C	O	T	C	O	T	C	O	T	C	O
Investments	4	19	23	93.9	18.6	59.5	72.6	267.5	67.3	53.3	0.09	0.09	215	267.5	267.5
Claims	4	19	23	35.1	25.8	74	96.7	226.8	74	3.4	0.251	0.251	220.5	226.8	226.8
Capital	4	19	23	28.3	17.1	54.9	89.6	266.7	76	1.1	0.05	0.05	148	266.7	266.7
G. Premiums	4	19	23	35.4	20.3	60.4	30.2	310.9	16.1	0.7	0.156	0.156	77.6	77.6	31.1

Table 4—illustrates descriptive statistics including mean, standard deviation, minimum, and maximum of the inputs and outputs variables for Takaful (T), Cooperative (C) and overall insurance companies in Saudi Arabia.

proposed by Banker, Charnes, and Cooper (1984). The latter will be determined by reference to Variable Returns to Scale (VRS) which encompasses both increasing and decreasing returns to scale (Charles, Kumar, & Irene, 2012). In fact, there are *a priori* reasons to stipulate that efficiency would be subject to variable returns and decreasing returns to scale. Thus, the method VRS improves an estimation of efficiency whether an increase or decrease in input or outputs does not result in a proportional variation (Cooper, Seiford, & Zhu, 2011). According to Majumder. and Datt. (2017), VRS takes into consideration the increasing, constant and decreasing returns to scale when working in Data Envelopment Analysis Program (DEAP).

Technical efficiency is calculated without the potential bias of the DEA efficiency estimators.

The monotonicity hypothesis as proposed by Charnes et al. (1978) is retained by Banker et al. (1984) model. However, we considered that all factors and products were freely available, and we implement the model of Banker et al. (1984) on our sample, which introduces a constraint of convexity to distinguish the efficiency of scale from the technical efficiency. To obtain the efficiencies of the entire set of units, it is necessary to solve a linear program converging on each unit in turn. Obviously, as the objective function is varying from problem to problem the weights obtained for each target unit may be dissimilar. The output-oriented linear programming model (Farrell, 1957) that measures pure technical efficiency is given below in its original form:

$$\begin{aligned} & \text{Max}_{\varphi_i, \lambda_j} \quad \varphi_i \\ \text{s/c} \quad & -\varphi_i y_i + Y \lambda_j \geq 0_M \\ & x_i - X \lambda_j \geq 0_K \\ & \mathbf{1}^N \lambda_j = 1 \\ & \lambda_j \geq 0_N \end{aligned}$$

$i = 1, \dots, N$, and N , is the number of companies.

Suppose that each of the N companies uses K inputs to produce M outputs (in our study $K = 2$ and $M = 2$). We note that x represents the input vector and y reflects the output vector. The matrices X of the dimension inputs (K, N) and Y of the dimension outputs (M, N) represent the data of the N insurance companies. The variables λ_i are non-negative weights or intensity variables defining frontier points. To this end, a formal approach for each company would require the determination of the weightings to be attached to each input and output quantity so that the following optimization program is solved:

$$\begin{aligned} & \text{Max}_{u,v} (uy_i/vx_i) \\ \text{s.c.} \quad & uy_j/vx_j \leq 1 \quad j = 1, \dots, N \\ & u, v \geq 0 \end{aligned} \tag{1}$$

where u is a dimension vector ($M, 1$) and v is a dimension vector ($K, 1$).

The resolution of this program consists in determining optimal values of u and v , so that the efficiency measure of the i^{th} company is maximized constraint that all efficiency measures must be less than or equal to one (Yannick, Hongzhong, & Thierry, 2016). The judicious choice of weights by each unit without taking account of the value of any input or output pretend that unit appears efficient but there may be concern that this is more to do with the choice of weights than any inherent efficiency. To avoid the multiplicity of solutions; for example, (u^*, v^*) is a solution, then $(\alpha u^*, \alpha v^*)$ is another solution and so on, one can impose the constraint $v \cdot x \ i = 1$, which provides:

$$\begin{aligned} & \text{Max}_{\mu, \nu} (\mu y_i) \\ \text{s.c.} \quad & \nu x_j = 1 \\ & \mu y_j - \nu x_j \leq 0 \quad j = 1, \dots, N \\ & \mu, \nu \geq 0 \end{aligned} \tag{2}$$

The new notation of the weights u and v reflects the transformation of the program from a form to a ratio to a multiplicative form of the linear programming problem. By using the duality of linear programming, one can derive a form of envelopment equivalent to this problem:

$$\begin{aligned}
 & \text{Min}_{\theta, \lambda} \theta \\
 \text{s.c.} \quad & -y_i + Y\lambda \geq 0 \\
 & \theta x_i - X\lambda \geq 0 \\
 & \lambda \geq 0
 \end{aligned} \tag{3}$$

where θ is a scalar and λ is a vector () of constants. The value of θ represents the efficiency score of the i^{th} company and satisfies the following inequality: $\theta \leq 1$. The unit value of θ indicates the boundary point, and the company in question is technically efficient Farrell. (1957). However, it should be noted that this linear program must be solved n times, once for each insurance company in the sample. An efficiency score is thus gotten for each company in 2014. To consider changes in scale economies (VRS), the convexity constraint $N1'\lambda = 1$ can be added to formulate the following program:

$$\begin{aligned}
 & \text{Min}_{\theta, \lambda} \theta \\
 \text{s.c.} \quad & -y_i + Y\lambda \geq 0 \\
 & \theta x_i - X\lambda \geq 0 \\
 & N1'\lambda = 1 \\
 & \lambda \geq 0
 \end{aligned} \tag{4}$$

The VRS and CRS specifications have been the most commonly used methods in the beginning of the 1990s. Based on the study of Berg, Forsund, Hjalmarsson, and Suominen (1993), we will estimate technical efficiency under the assumption of VRS and CRS. All in all, the general empirical estimated model will be:

$$\text{Volume of (Investment, claims)} = \text{Volume of (Capital, Nets premiums)}$$

According to Majumder and Datt (2017), VRS takes into consideration the increasing, constant and decreasing returns to scale when working in Data Envelopment Analysis Program (DEAP) (see Figure 2).

The effect of the scale assumption on the measure of capacity utilization is demonstrated in Figure 1. Four data points (A, B, C, and D) are employed to approximate the efficient frontier and the level of capacity utilization under the assumption of VRS. With this assumption, the frontier is defined by points A, C and D, and only point B lies below the frontier, i.e. exhibits capacity underutilization. CRS reflects the fact that output will change by the same amount as inputs are changed (e.g. a doubling of all inputs will double output).

Figure 1. Insurance penetration breakdown during the period 2011–2016.

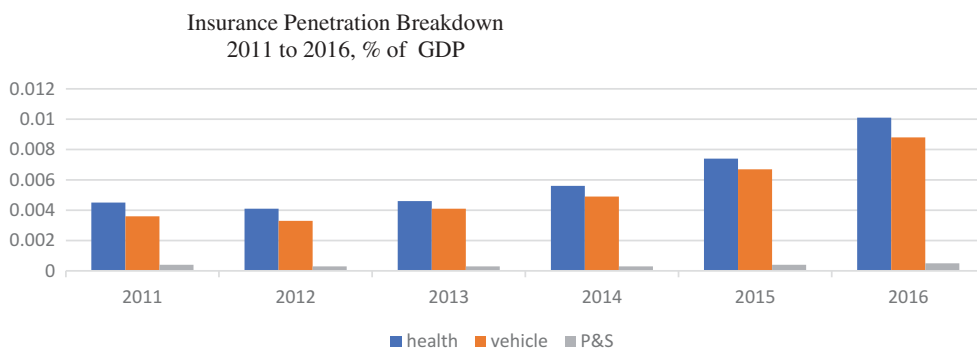
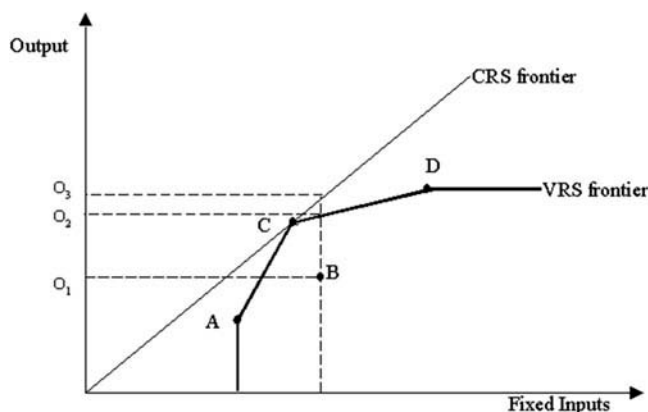


Figure 2. VRS and CRS frontiers.¹



3. Empirical results

In this section, we are interested in analysing the correlation matrix and secondly, we summarize results for DEA-VRS and DEA-CRS models. Thus, we provide aggregate results for the different organizational forms—cooperative and takaful—in Saudi Arabia. In Table 6, the insurers are grouped by type of organizational form (cooperative and takaful) to test whether cooperative and takaful insurers operate on the same pooled frontier or on separate frontiers.

3.1. Correlation matrix

Table 5 illustrates the correlation matrix between inputs (Premiums, Capital) and outputs (Investment and Claims) variables.

Pearson’s correlation coefficients test is used in this matrix to determine the presence of correlation among the inputs and outputs. Generally, statistics on input (output) data show a weak correlation between all deposits and loans variables, except the dependence structure between Claims and G. premiums. In fact, the coefficient of linear correlation is more than 0.5 over the study period. As a concept, insurance works by pooling the premiums of the many to pay for the claims of the few. The insurer which experiences higher claim frequency and severity should command higher premium.

$$(\text{Claim Frequency} \times \text{Claim Severity}) + \text{technical expenses and policy fees} = \text{Gross premium}$$

3.2. Efficiency scores

Many researchers (Barros, Barroso, & Borges, 2005; Ertugrul et al., 2016; Micajkova, 2015) have explored technical efficiency scores that obtained from a DEA-CRS (total technical efficiency) in the insurance field into two mechanisms:

Table 5. Correlation matrix				
	Investments	Claims	Capital	Premiums
Investments	1			
Claims	0.17	1		
Capital	-0.25	-0.14	1	
G. Premiums	-0.02	0.54***	-0.084	1

(***), significant at 1% level.

Table 6. Efficiency scores results

Company	VRS-DEA	CRS-DEA	Scale	Company	VRS-DEA	CRS-DEA	Scale
1	0.386	0.061	0.158	13	0.73	0.615	0.842
2	1	1	1	14	0.211	0.133	0.63
3	1	1	1	15	0.407	0.202	0.496
4	0.324	0.006	0.018	16	0.548	0.092	0.167
5	0.868	0.261	0.3	17	0.338	0.17	0.503
6	0.955	0.239	0.25	18	0.809	0.523	0.646
7	0.408	0.282	0.691	19	0.366	0.203	0.554
8	1	0.181	0.181	20	0.705	0.514	0.729
9	0.151	0.121	0.801	21	1	1	1
10	0.025	0.023	0.92	22	1	1	1
11	0.027	0.024	0.888	23	1	1	1
12	0.155	0.155	1	Mean	0.583	0.383	

Note: The first four companies work under the principle of Takaful, the rest are cooperative insurance companies.

- The first component is caused by *pure efficiency* (DEA-VRS) and expresses the percentage of total technical efficiency that is purely due to technical efficiency, as indicates by its name.
- The second one is provided by *scale efficiency* and reflects the part of total technical efficiency explained by the compatibility of the production scale at which the company operates.

As in this study, this may be done by conducting both a DEA-CRS and a DEA-VRS upon the same data. If there is a significant difference between the two-technical efficiency score for a specific DMU, then this demonstrates that there is a scale inefficiency (Coelli, Rao, O' Donnell, & Battese, 2005), and that the scale inefficiency can be calculated from the difference between the DEA-VRS score and the DEA-CRS score. The results are summarized in Table 6. That stands for the two models.

In the case of DEA-VRS, scores vary between 0.025 (lower) and 1 (highest). The average pure efficiency score is 0.79. As for the case of DEA-CRS, scores are bounded by 0.023 (lower) and 1 (upper). And the average total efficiency score is 0.383. Thus, efficiency scores decrease under DEA-CRS assumption. The distribution of companies in each case is presented in Table 6.

This table shows the similarity in technical efficiency between DEA-VRS and DEA-CRS frontiers. The similarity between methods is great in most of cases considered. The current DEA-VRS showed six insurance companies as efficient, namely 2, 3, 8, 21, 22 and 23, but we note that the 8th company is not efficient in the models considered DEA-CRS.

The efficiency under variable returns to scale and constant returns to scale will be taken into consideration. Within the first model, the proportion of cooperative insurance companies which have an average of superior appraisal corporation's technical efficiency score (superior to 0.5) is equal to 52.8%. Moreover, there is 50% (2 insurance companies) of the Takaful insurance that have scores inferior to 0.5, meaning they get the lowest scores. Better the insurance companies on the frontier (score = 1) are parts of the Takaful type (two companies) and cooperative type (four companies). In addition, some individual efficiency scores are close to the very weak efficiency value (precisely for 9, 10, 11 and 12). This is due to the fact that some of the cooperative companies only distribute to the policyholders all or part of any annual surplus arising from the insurance operations, rather than investing (Maysami & Kwon, 1999). Moreover, 60.8% of companies achieved scores above half. The remaining became below 50% efficiency score and stay under that figure. As for the second model, 15 (65.2%) have scores less than 0.5. Thus, few companies in

both industries (Takaful and cooperative) are efficient as they can produce maximum output for a given input in both CRS and VRS. The reason might impact be Saudi Arabian economy that has been jolted by a severe oil shock, in the year of 2014. Nevertheless, based on geometric means, it can be summarized that Cooperative insurance sector is more efficient under both CRS and VRS as compared to Takaful insurance sector.

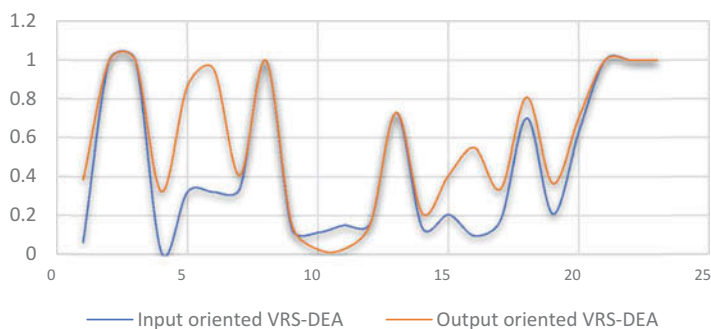
The results relating to returns-to-scale in Saudi Arabian insurance companies highlight that the predominant form of scale inefficiency is the reducing returns-to-scale imply that an insurance has an inefficient large size, like what is mentioned by Akhtar (2018) and Ben Jedidia and Medhioub (2015). This means that the values of claims and investment are lesser than the given values of total gross premiums and Capital. More specifically, the average number of insurance companies with weak returns to scale was 6 imply that these companies have an inefficient large size. Consequently, these companies have not reached their optimal scale yet, which is mostly observed in small-size companies. Comparing the efficiencies between cooperative and Takaful insurance, we observe that the cooperative insurance companies perform better of the year. Regarding the scale efficiencies, it is evident that the cooperative insurances operate very close to their optimal scale. Hence, these companies operate with full utilization of inputs and optimal scale. This result confirms those of Al-Amri (2015) and Taib, Ashraf, and Razimi (2018).

The overall efficiency score of the sample is found to be 0.583 meaning that there exists an acceptable scope for improvement of technical efficiency in Saudi Arabian insurance industry. This is similar to the findings of Ben Jedidia and Medhioub (2015).

When mean efficiency scores of Takaful and cooperative insurance companies are compared, it reveals that cooperative insurance sector (mean efficiency = 0.563) perform worst regarding technical efficiency and Takaful insurance sector (mean efficiency = 0.677) is best in that respect. The difference in mean efficiency score of Takaful and cooperative units is marginal. Therefore, many cooperative insurance sectors must work hard to improve their efficiency through a broad-based policy. This policy provides comprehensive coverage on the big-ticket items, such as the buildings, as well as named perils coverage on the contents.

Figure 3 represents both input and output-oriented DEA-VRS, insurance companies 2, 3, 8, 21, 22 and 23 with technical efficiency of 1. The chart shows both inefficient and efficient insurance companies. Thus, their returns to scale must improve by effective inputs and outputs, so as, to become efficient. Basing on the showed analysis it was claimed that in the insurance sector in each year there is a need for efficiency development through effectively used manufacturing techniques reflecting use of inputs in order to manufacture the output (Jarzębowski, 2014). For example, insurance company 1 from output-oriented DEA-VRS, needs to improve its finances, so as, to achieve a rise of 61.4% to become efficient.

Figure 3. Graph showing the insurance companies having technical efficiencies.



For the summary of slacks, we try to know the value which displays the discrepancy in the constant or proportional change of output and input variables. The results showed that all the insurance companies except for 1, 2, 3, 4, 21, 22 and 23, has slacks that caused a proportional change of output and input variables. Interpretation indicates that insurance company 6 with the proportionality of total Claims and investment (output variables) either decreased or increased by 301.081 to become efficient. Similarly, insurance company 11 must improve its efficiency by increased or decreased total Claims and investment by 149.482. For the rest of the inefficient insurance companies, similar interpretations are to be made.

The Table 7 indicates that the 1st insurance company must either follow the input-output variables of 23rd, 3rd and 21st insurance company. Moreover, the most companies must follow the proportional input-output variables (G. Premiums: Capital: Investment: Claims of 21st and 22nd insurance companies. But the Takaful insurance as a benchmarked or referred insurance company is the 3rd company which output-input proportionality can be followed to become efficient.

Again, according to Table 8, peer weights of insurance company show that the insurance 1 can either follow 219.8% of the 3rd company's values or follows 195% of 21st company's values. Similarly, many cooperative insurances must connect patterns of variation between 26.8% and 188.5% of the output variables of Insurance 21. In order to attain technical efficiency of Takaful insurance by a cooperative insurance, the minimum proportion of the company's value, that meets the requirement of efficiency, is equal to 24.4%. Furthermore, Insurance companies 21, 22 and 23

Table 7. Summary of slacks in DEA

Companies	Summary of output slacks		Summary of input slacks	
	1	2	1	2
1	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000
4	0.000	0.000	0.655	0.000
5	81567.112	0.000	0.000	163.002
6	124775.456	0.000	0.000	301.081
7	46467.266	0.000	0.000	0.000
8	56663.152	0.000	0.000	0.000
9	18578.034	0.000	0.000	0.000
10	0.000	0.000	111.320	0.000
11	126.201	0.000	149.482	0.000
12	183.574	0.000	0.000	0.000
13	8670.138	0.000	0.000	0.000
14	835.038	0.000	0.000	0.000
15	5266.908	0.000	0.000	0.000
16	4405.865	0.000	0.000	0.000
17	6821.240	0.000	0.000	0.000
18	35641.896	0.000	0.000	0.000
19	6989.516	0.000	0.000	0.000
20	21875.220	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000
Mean	18211.592	0.000	11.368	20.178

Table 8. Summary of peers or reference units

	Peers			Peer weights			Peer count (i.e. no. times each firm is a peer for another)
1	23	3	21	16.512	2.198	1.950	0
2	2			1.000			0
3	3			1.000			0
4	23	3	21		1.189	1.012	0
5	21	22		2.223			0
6	21	22		2.324			0
7	21	22		0.819			0
8	21	22		0.742			0
9	21	22		0.958	6.828		0
10	23	3		0.101	0.244		0
11	3			0.176			0
12	21	3		0.400	0.552		0
13	21	22		0.167	1.722		0
14	21	3		0.686	0.929		0
15	21	22		1.885	5.689		0
16	21	22		0.511	9.453		0
17	21	22		0.702	9.650		0
18	21	22		0.268	9.927		0
19	21	22		1.281	9.909		0
20	21	22		0.325	5.499		0
21	21			1.000	1.000		16
22	22			1.000	1.000		12
23	23			1.000	1.000		3

as the benchmarked insurances whose output-input proportionality can be followed to become efficient, has been benchmarked or referred 16, 12 and 3 times, respectively.

There are alternative methods that could be used. Several studies employed other powerful models which could be considered serious statistical or econometric limitations. For example, Stochastic frontier efficiency SFA which was independently formulated by Aigner, Lovell, and Schmidt (1977) and Battese and Corra (1977) and has been employed by several authors. In such case, Katharakis, Katharaki, and Katostaras (2014) stipulated that this parametric approach method can be used as compared to DEA, because it is suited to measure efficiencies of stochastic industry for input/output information. Relatively few studies have been conducted on the cost efficiency of Takaful insurers. Roziana and Isa (2013) applied a flexible cost functional form to measure the relationship between efficiency and organizational structure for Takaful and insurance operators in Malaysia’s dual financial system., while Bezat (2011) estimated the SFA method based on the Cobb–Douglas function.

The stochastic cost frontier approach supposes that a firm’s observed cost deviates from the cost frontier, because of a random error and possible inefficiency. We selected the Fourier Flexible (FF) functional form to satisfy the theoretical properties of all data points (Altunbas, Evans, & Molyneux, 2001; Yu, Escalante, & Deng, 2007) using the maximum-likelihood method.

Overall, results show that average cost efficiency for Takaful companies and cooperative insurance were 74.33% and 62.75% in 2014. Cooperative companies are somewhat less efficient than the choice of input combinations that can minimize costs compared to Takaful insurance companies. The results illustrate that the cost efficiency appears to be an important source of growth to efficiency change. Comparing the results with those from the DEA method, all companies proved significant and likely similar.

4. Conclusion

This study has attempted to assess the technical and scale efficiency of the Saudi Arabian insurance companies. The efficiency scores are computed using DEA, which is a non-parametric method employed to model the association between multiple inputs and outputs for a decision-making unit (DMU). This methodology offers estimates of the possible development that can be made in inefficient units, in our case inefficient insurance companies, and thus, it allows to identify benchmarking companies in Takaful and cooperative insurance companies, so that the best practices of peers can be implemented to become efficient one.

From our analysis of overall technical efficiency and scale efficiency we find that on average, the insurance companies suffer from inherent problems of enforceability and verifiability that both conduct to significant inefficiencies and generate unavoidable trade-offs between inputs and outputs in the year 2014. The origin of the work is based on fact that technical efficiency can be improved through adequate allocation of Gross premiums and capital of the firm in different business lines.

Then, the gross inputs and capital are considered as inputs to DEA model. The claims and investment occurring in a unit are treated as outputs of the model and signify the efficiency of a firm. DEA approach helps to identify the benchmarking organizations which can be referred by inefficient units to become efficient one. The first approach of DEA known as DEA-VRS is considered to obtain efficiency of DMUs. Our analyses revealed an average efficiency score of 58.3%, from 2014. Six units out of 23 are found to be strongly efficient in VRS model (DMU2, DMU3, DMU8, DMU21, DMU22, and DMU23) based on their efficiency scores, but among them there are two Takaful companies. With respect to DEA-CRS, the score of efficiency is 38.3%. Then, it seems that Takaful insurance companies are relatively more efficient than cooperative ones. This result does not confirm the works of Antonio et al. (2018), Saad (2012) and Ismail et al. (2011), but it confirms the findings of Dewi and Murni (2016).

All in all, the scores proved that generally speaking the cooperative assessed were technically inefficient in converting resources into investment and claims, during the study period. That is mostly due to a discordancy of production scale with a scale inefficiency of 33.7% on average. The same statement may probably hold if the remaining insurance companies, which have not been included in the sample, were considered, since the main largest companies that have the best practices in the sector have already been considered. To sum up, careful attention should be paid to the conclusion of this paper and to how findings are to be employed. The result of this analysis should not serve as a background for immediate policy responses, with regards to the optimal use of the natural resources for the achievement of sustainable growth of insurance sector. It rather points out special directions for the efficiency improvement of future Cooperative and Takaful operations in Saudi Arabia.

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Notes

1. Since the cooperative insurance company licensed by SAMA (promulgated in FY03), the insurance industry has seen new trend that has seen a huge influx of many insurance companies breaking into the market (35 registered insurers today). The number of new entrants over such a short period has led to a “fragmented” market characterized by intense competitive rivalry accompanied by a multi-lateral series of price increase and capital erosion for market composition.
2. The Gross Domestic Product per capita in Saudi Arabia was last recorded at 50.4 (50.7) US dollars in 2016 (2015, when adjusted by purchasing power parity (PPP)).
3. Reported SAMA (2016).
4. Source: Pascoe, Kirkley, Greboval and Morrison-Paul (2003).

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