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Efficiency Analysis of Traditional and Takaful Insurance Firms in Egypt: A Two-Stage Efficiency Model

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Abstract
The purpose of this study is to measure and analyze the efficiency of insurers (traditional, takaful) in Egypt, and to examine the determinants (Insurer-specific factors) that appear to affect the efficiency of insurers. The study uses a two-stage efficiency model: (1) input-oriented Data Envelopment Analysis (DEA), a non-parametric model to measure the efficiency of 17 non-life insurers (12 traditional, 5 takaful) in Egypt during the period from 2012 to 2021, and (2) a panel regression model to examine the determinants (Insurer-specific factors) of efficiency in the traditional and takaful insurance industry in Egypt. This study found that on average, the technical efficiency (TE) level of non-life insurers (traditional and takaful) was 79%, and there is still a need for 21% efficiency to improve the efficiency in the industry, moreover, takaful insurers achieved a better efficiency level than traditional insurers. On the other hand, the findings also showed that return on equity, size, type of operations, and age are positively related to insurers' efficiency, while reinsurance, claims (risks), market share, leverage, and investments are negatively related to insurers' efficiency. This study provides indicators relevant to insurance management (traditional and takaful) that will help them better utilize their resource base and increase their operational efficiency; to our knowledge, this paper is the first empirical evidence for traditional and takaful insurers together to measure efficiency and examine its determinants in Egypt.

***Keywords**: Efficiency, DEA, Panel regression model, Takaful, Insurance, Egypt.*

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1. Introduction

The Egyptian insurance industry is undoubtedly unique because of its dual insurance system, comprising traditional (commercial) and takaful insurance. In recent years, the Egyptian insurance industry has experienced significant growth, accompanied by the establishment of takaful insurers (Hafez and Hassan, 2020). This remarkable information compels us to examine the efficiency of the traditional and takaful insurance industries. Egypt is a highly populated nation that has businesses active in both traditional and takaful, with both industries operating together. By adopting the Insurance Law of 1998, raising the paid-up capital of traditional and takaful insurers, enacting the Takaful Act of 2003, and establishing regulatory control of the industry, the Egyptian government has contributed to the development of this industry (Murad, 2018). The insurance sector in Egypt consists of 39 companies: 29 insurers engage in traditional (commercial) insurance, comprising 12 life insurers and 17 non-life insurers, including the Egyptian Export Guarantee Company. Meanwhile, 10 insurers specialize in Takaful, with 4 life insurers and 6 non-life insurers. The total written insurance premiums by traditional insurers

amounted to EGP 41 billion, while the total written insurance premiums by takaful insurers amounted to EGP 6 billion for 2021 (Statistical Yearbook of the Egyptian Insurance Market, 2021–2022). Takaful insurance, a Sharia-compliant alternative to traditional (commercial) insurance, is rapidly expanding, with projections indicating a 50% increase in its market share over the next five years. While Islamic (takaful) insurance makes up around 15% of the insurance market (Othman, 2021), the insurance industry as a whole only contributes around 0.7% of GDP. Efficiency has gained attention in the insurance industry since it can help determine which companies are efficient and which are not; enhance profitability and competition; and raise policyholder trust (Rubio Misas, 2024). Efficiency refers to an insurance company's ability to generate a specific set of outputs through the utilization of inputs (Ming, 2020). Research on efficiency within financial services, especially in the insurance industry, is becoming prevalent in empirical research. Over the past decade, there has been an increasing focus on evaluating the efficiency and productivity of companies within the financial services sector, with insurers specifically identified as a segment that can significantly benefit from such analyses. Frontier approaches, such as data envelopment analysis (DEA) and stochastic frontier analysis (SFA), are often used to assess the comparative performance and efficiency of specific entities relative to their peers. The literature is currently available on insurance (both traditional and takaful) focuses more on cross-country efficiency comparisons, which offer important insights into the competitiveness and performance of insurers across nations (Kamran et al. (2023); Al-Amri et al. (2021); Ali et al. (2021); Eling & Luhnen (2010); Biener & Eling (2012)). Several studies have concentrated on evaluating the efficiency of insurers within specific nations. Tone & Sahoo (2005) in Japan; Zhu (2019) in China; Ansah-Adu et al. (2012) in Ghana; Abu Assi (2022) in Syria; Jaloudi (2019) in Jordan; Abbas et al. (2018) in Pakistan; Ennsfellner et al. (2004) in Austria; Cummins & Rubio-Misas (2006) in Spain; Cummins & Xie (2008) in the US insurance industry; Chen & Chang (2010) and Hwang & Kao (2006) in Taiwan; Akhtar (2018) in Saudi Arabia; Ming (2020) in Malaysia. The insurance industry (traditional and takaful) in Egypt is not yet mature and is characterized by intense, unhealthy competition, unfair pricing policies, limited product range, lack of risk assessment methodology, and lack of use of advanced technology (Hafez and Hassan, 2020). Therefore, identifying the efficiency gap is a key issue to improve the competitiveness of the insurance industry in Egypt. For Egyptian insurance studies, most of the existing ones, such as Hafez & Hassan (2020) and Othman (2021), focus on traditional insurers and do not take into account the takaful companies that operate with them in the same market. Also, a few studies, such as Saeed (2018), focused on takaful insurers and ignored traditional insurers. Until now, no empirical study in Egypt has examined the efficiency determinants of both traditional and takaful insurers. By focusing on the investigation of the efficiency of traditional and takaful insurers in Egypt as well as the factors that influence efficiency, this research aims to provide novel empirical contributions to the growing body of studies on efficiency. Therefore, this research's goals are twofold:

(1) Employ Data Envelopment Analysis (DEA) to measure and analyze technical efficiency (TE), pure technical efficiency (PTE), and scale efficiency (SE) using data from 2012 to 2021, as well as investigate any differences in efficiency between traditional and takaful insurers.
(2) Employ a panel regression model to investigate the efficiency determinants (insurer-specific factors) that seem to affect the efficiency of traditional and takaful insurers.

Efficiency in insurer operations affects performance and outcomes (Zhu, 2019), making this paper important. Currently, the challenges facing the insurance sector in Egypt, such as low returns on assets, minimal contributions to the gross domestic product, and a reduced per capita share of insurance (Othman, 2021), underscore the importance of efficiency among insurers. This paper provides insurance managers with a useful indicator to help them make effective use of the resource base. The research period encompasses the period following the enactment of the Insurance Law and the issuance of most of the legislation about the operations of traditional and

takaful insurers. This paper covers a literature review, a discussion of relevant efficiency studies, data and methodological approaches, the presentation, and analysis of empirical findings, as well as conclusions and recommendations.

2. Literature Review

The literature on examining efficiency in the financial industry is rapidly expanding. Researchers have conducted numerous efficiency studies of the insurance industry using two different methodologies: parametric (stochastic frontier analysis (SFA)) and non-parametric (data envelopment analysis (DEA)). A large body of literature measures the efficiency of the insurance industry at the state level. Some studies have estimated the efficiency of the US insurance market, for example, Cummins and Xie (2016) estimated the efficiency of 781 property and liability insurers in the United States from 1993 to 2009, using a sample of the largest companies operating with a declining return to scale. Copeland and Cabanda (2018) used data envelope analysis (DEA) to measure and analyze the efficiency of the U.S. publicly owned insurance industry for a sample of 47 publicly owned insurers for the 2011–2013 period. In the second stage of the analysis, they employed Tobit regression to investigate the relationships between efficiency and insurers' financial performance. Their results showed that efficiency did not improve over time, as well as a significant positive association between insurers' financial performance and efficiency. Also, several researchers have examined the European insurance industry, including Cummins and Rubio Misas (2001) and Noulas et al. (2001) concurrently examined the insurers in Greece and Spain, discovering that the firms exhibited declining returns to scale. Biener et al. (2016) performed a study from 1997 to 2013 to assess the efficiency and productivity of the insurance industry in Switzerland, covering the life, non-life, and reinsurance industries. This research includes two stages. At first, they employed an input-orientated data envelope analysis (DEA) and the Malmquist index (MPI). In the second stage, they analyzed eight hypotheses regarding factors, seven of which evaluated the correlation between the efficiency of industry and seven variables: organizational structure, international diversification, company age, scale, scope economies, senior growth, and leverage. The findings revealed that only the reinsurance and non-life segments of the Swiss insurance industry saw improvements in productivity and efficiency, while the life insurance industry remained stable. On the other hand, researchers such as Barros and Wanke (2014) and Alhassan and Biekpe (2015) have investigated the technical efficiency and capacity of insurers in Mozambique and South Africa, revealing high levels of technical inefficiency. Huang and Eling (2013) examined the insurance industry's behavior in the BRIC countries—Brazil, Russia, India, and China—and found that Brazil is the least technically efficient, while it is the most efficient. Jaloudi (2019) evaluated the technical efficiency of Jordanian insurers, noting a slight improvement during the study period and significant differences in efficiency across different insurers; furthermore, the efficiency of an insurer significantly depends on its type, size, and return on assets. Zhu (2019) examined the Chinese non-life and life insurance industry from 2008 to 2011, as well as the determinants of the efficiency of Chinese insurers, and found that the Chinese insurance industry has high technical efficiency, and the size of assets and the nature of capital (domestic or foreign) have a positive effect on efficiency.

Most Islamic countries use takaful insurance. Some researchers have tried to examine the efficiency of the takaful insurance industry. Ali et al. (2021) applied the DEA technique to calculate the technical efficiency of 41 takaful insurers in 16 countries (Sudan, Bahrain, Egypt, Indonesia, Bangladesh, Malaysia, Saudi Arabia, Qatar, Pakistan, Kuwait, Jordan, Iran, Sri Lanka, Syria, Yemen, UAE) during the period from 2009 to 2014. They found that takaful companies in Egypt, Bangladesh, Pakistan, and Yemen showed superior performance compared to takaful companies in other countries in the study sample. Bao et al. (2018), Rahman (2015), and Akhtar (2018) compared the efficiency of both types of insurers (traditional and takaful) operating in Malaysia, Bangladesh, and Saudi Arabia and concluded that the efficiency of traditional insurers is higher than that of takaful insurers. Miniaoui and Chaibi (2014) conducted a comparative

analysis of Malaysia and the GCC countries for the period 2006-2009, taking a sample of 12 Takaful companies (four from Malaysia, three from the UAE, two from Qatar, two from Saudi Arabia, and one from Bahrain) and found that the Malaysian market is less efficient than the GCC countries. Also, Kader et al. (2010) used data envelopment analysis (DEA) to measure the cost efficiency of 26 non-life takaful insurers from a sample of 10 Islamic countries and found that the cost efficiency score was 0.70. In contrast, some researchers have examined the efficiency of traditional and takaful insurers, including Singh and Zahran (2013), who investigated the cost efficiency of both types of insurers for 8 countries in the Middle East and North Africa region, i.e., Bahrain, Qatar, Saudi Arabia, Kuwait, Egypt, Jordan, and Tunisia. They found that takaful insurers are less efficient than traditional insurers due to their Sharia-compliant products. The empirical literature has extensively explored the determinants of efficiency. Ashraf (2019) used the Tobit regression model to determine the effect of insurance company characteristics (return on equity (ROE), leverage, market share, and asset size) on the efficiency of the insurance industry (traditional and takaful) in Pakistan. Ming (2020) used a second-stage panel regression analysis to discover the factors (leverage, reinsurance, product diversification, company size, ownership, and insurer age) that affect insurers' performance (traditional and takaful) in Malaysia. Using both SFA and DEA methods, Eling and Luhnen (2010) investigated insurers' efficiency in 36 economies from 2002–2006. The results of the DEA indicated that the cost efficiency of general insurers was 38%, and that of life insurers was 59%. The findings of SFA showed that the cost efficiency of general insurers was 59%, and that of life insurers was 74%. Furthermore, they used Tobit regression analysis to examine the efficiency determinants and discovered that mutual funds were more efficient than equity funds. They also found a positive relationship between size and inefficiency scores, while the solvency ratio showed a negative relationship. Lee et al. (2019) aimed to discover the determinants affecting the efficiency levels (technical efficiency and cost efficiency) of the takaful industry and to investigate the impact of insurers' specific factors related to takaful insurers on the efficiency of takaful insurance in Malaysia. Their findings revealed that takaful operators often exhibit allocative inefficiency; however, family takaful demonstrated greater cost efficiency compared to general takaful. Ilyas and Rajasekaran (2019) analyzed the Indian general insurance business in terms of efficiency, productivity, and economies of scale returns. To find bias-corrected efficiency scores, they used DEA bootstrapped regression. To find out how firm-specific variables affected insurers' efficiency, they used truncated bootstrapped regression. Their findings indicated that public insurers exhibited more cost efficiency than private insurers, whereas size and reinsurance showed a statistically significant negative correlation with efficiency. Alhassan and Biekpe (2015) used truncated regression to identify the determinants of efficiency for South African insurers and concluded that product line diversification was positively associated with efficiency, while age, leverage, reinsurance, and size were negatively associated with efficiency. Although there are some research papers that examined the efficiency of insurers in Egypt, such as Hafez (2022), Murad (2021) on traditional insurers, and Saeed (2018) on takaful insurers, there is no study on Egypt that compared the efficiency of traditional insurers with takaful insurers (gap). Furthermore, previous studies have not examined the determinants of the efficiency of insurance companies in Egypt (gap).

3. Research Methodology

3.1 Data and variables

The research utilized secondary data from the Egyptian Financial Supervisory Authority's annual statistical book for the traditional and takaful non-life insurance industry from 2012 to 2021. The sample consists of seventeen insurers (12 traditional, 5 takaful), including Misr, Suez Canal, Mohandes, Delta, AIG, GIG, Chubb, Royal, Allianz, Bupa, Arope, Iskan, Egyptian Saudi, Egyptian takaful, Wethaq takaful, Tokio Marine, and Orient takaful, which holds more than 85% (in terms of premium) of the non-life insurance market share. The period was chosen because although the takaful insurers started their operations in 2003, all five started their operations fully in 2012. In many traditional and takaful insurance industry studies, efficiency is the equation of inputs and outputs. Traditional and takaful insurers aim to produce profitable businesses and maximize

shareholder wealth; takaful also benefits policyholders (Al-Amri et al., 2021). The insurance and takaful underwriter constantly seek to select specific types of insurable risk applications from proposals submitted by insurance policyholders. The firm can achieve underwriting profit by selecting potential insureds based on its underwriting criteria, which should result in low claims (Rejda, 2011). Meanwhile, the management team is also involved in day-to-day operations, such as auditing, accounting, agency marketing, legal services, broking, loss surveying, etc. The company's employees, responsible for running day-to-day operations, use management expenses as inputs (Rejda, 2011), resulting in three main inputs: equity, general and management expenses, and claims. These selected inputs (general and management expenses, equity, and net claim incurred) are in line with Zimková (2015), Al-Amri (2015), Biener et al. (2016), Alhassan and Biekpe (2015), Bao et al. (2018), and Akhtar (2018). The primary goal of traditional and takaful insurers is to achieve positive investment income from the insurance premiums collected (Bansal and Singh, 2021). Traditional insurers and takaful operators collect premiums or contributions from policyholders and then invest the funds raised naturally in low-risk investment assets. These selected outputs (net investment income and premium or contribution collected) are consistent with Keong (2015), Zhu (2019), Jaloudi (2019), Eyob (2021), Kamran et al (2023), Abbas et al (2018), Biener et al (2016), and Al-Amri (2015). Table 1 gives details about the input and output variables. Table 2 displays the descriptive statistics results for the input and output variables selected in the study for traditional and takaful non-life insurers. Table 3 shows the list of independent variables, along with a description of the variables and their expected and actual relationship with the efficiency scores, as reported by the following authors: Alhassan and Biekpe (2015), Nourani et al. (2018), Ashraf (2019), Ming (2020), Bansal and Singh (2021), Gharaei et al. (2020), and Kamran et al. (2023).

Table 1: Description of variables chosen in the study (input and output)

Variables	Definition	Source
Inputs		
General and management expenses	Includes general and management expenses and commissions paid at the end of the year.	Annual Report
Equity	It is the net assets of the company, and is defined as the remaining value of the company's assets after its liabilities are subtracted.	Annual Report
Net claim incurred	It represents the outstanding claims at year-end plus claims disbursed during the year, subtracting the outstanding claims at the beginning of the year.	Annual Report
Outputs		
Premiums or contributions	It refers to the total amount of premiums collected or written by an insurance company during the year from policyholders.	Annual Report
Net investment income	The annual net income from financial investing operations.	Annual Report

Table 2: Descriptive statistics results for input and output variables

Traditional non-life insurers					
Variables		**Mean**	**S. D**	**Min**	**Max**
Inputs	Equity	1118.9	3437.5	62.9	18982.3
	General and management expenses	97.3	172.3	4.7	850.3
	Net claim incurred	258.1	567.2	0.15	3361.3
Outputs	Net investment income	127.5	294.5	1.7	1436.6
	Premiums or contributions	464.1	1003.7	11.6	5466.7
Takaful non-life insurers					
Inputs	Equity	199.6	153	15.7	745.7
	General and management expenses	16.6	12.2	0.33	50.6
	Net claim incurred	89.9	80.5	15.5	370.7
Outputs	Net investment income	50.5	79.3	2.1	490.1
	Premiums or contributions	159	132.3	24.8	545.9

***Source**: Field data collection, the annual statistical book of the Egyptian insurance market. Note: Values are in Million EGP (Egyptian pound).*

Table 3: List of independent variables in Panel regression analysis

Insurer-specific factors (determinants)	Measure	Source	Expected Relation	Actual Relation
Company size	Natural logarithm of total assets.	Annual Report	±	±
Insurer Age	The number of years since the establishment of the insurer in Egypt.	Annual Report	±	+
Reinsurance (%)	Premiums ceded to the reinsurer.	Annual Report	±	±
Underwriting risk (%)	Net claims / net premiums.	Annual Report	-	-
Financial profitability (%)	ROE: profit before tax / equity.	Annual Report	+	+
Investment profitability (%)	Investment income / premium income.	Annual Report	-	-
Market share (%)	The premium of each company to the total premiums.	Annual Report	±	±
Leverage (%)	The equity to total assets.	Annual Report	-	-
Operating type	A dummy variable that indicates the type of operations. 1 = takaful insurer; 0 = traditional insurer	----	+	+

Source: *Prepared by the author.*

3.2 Approach

Stage One: Data Envelopment Analysis (DEA)

Data envelopment analysis (DEA) employs mathematical programming to create a production frontier from a collection of linear segments. The frontier includes companies that exhibit the optimal combination of inputs and outputs, linking the most efficient companies to their peers at any time (Rubio-Misas, 2024). Since DEA is an empirical methodology that eliminates certain assumptions and constraints associated with standard efficiency assessment techniques, it serves as a valuable supplement and alternative to the traditional production function approach. Many industrial applications show that data envelopment analysis is useful for judging performance in many business fields, including the insurance industry (Banker et al., 2019). This is because it can handle many inputs and outputs without needing to specify the form of the production function. The traditional Cobb-Douglas production function is employed to investigate allocative and technical efficiencies; however, its limitation in recognizing only central tendencies precludes it from assessing the relative efficiency of each of the decision-making units or companies (Cooper et al., 2003). Charnes et al. first introduced data envelopment analysis (DEA) in 1978 with constant returns to scale (CRS), and Banker et al. expanded it in 1984 to include variable returns to scale (VRS). It has become a modern technique for performance measurement and efficiency evaluation, widely adopted across different sectors. Data envelopment analysis includes output or input orientations. The output-oriented model aims to determine technical inefficiency through a proportional enhancement in output production while maintaining constant input levels, whereas the input-oriented model aims to measure technical inefficiency through a proportional reduction in input utilization while keeping output levels constant (Coelli et al., 2005). This research looks at how efficient traditional and takaful insurers are. It uses an input-oriented model because both types of insurers want to maximize business benefits while minimizing debt capital costs and operating expenses (Ashraf, 2019). Managers have a lot of control over these inputs (Akhtar, 2018). Given that various company-specific factors (e.g., insurer types, market share, size, and age) and market limitations prevent traditional and takaful insurers from operating at an optimal scale, the variable return to scale (VRS) assumption is more appropriate for our sample. The variable return to scale assumption provides an allowance for isolated managerial efficiency/inefficiency. Banker et al. (1984) looked into how well variable return to scale (VRS) worked by adding a convex constraint ($N1'\lambda = 1$) to the initial CRS model, which was input-oriented. This study follows their VRS input-oriented DEA model, which can be written as follows:

Input - Oriented VRS Model

$$\theta^* = min\, \theta_{\theta,\lambda}$$

subject to:

$$Y_{rj}\lambda_j \geq Y_{r0} \qquad r = 1, \dots, s$$
$$\theta X_{i0} - X_{ij}\lambda_j \geq 0 \qquad i = 1, \dots, m$$
$$N1'\lambda = 1 \quad \textit{(convexity constraint)}$$
$$\lambda_j \geq 0 \qquad j = 1, \dots, n$$

……(1)

Where: X_{ij} : it means the amount of the i^{th} input (net claims incurred, equity, and general and management expenses) at DMU_j (traditional insurers and takaful insurers). Y_{rj} : Means the amount of the r^{th} output (net investment income, and premiums) at DMU_j (traditional insurers and takaful insurers). Θ^* : Represents the company's efficiency score. *N1*: is an *I*1* vector of ones. λ_j : It is a weight vector that determines the linear combination of DMU_j peers (traditional insurers and takaful insurers). The DEA score obtained ranges between 0 and 1. An insurer operates below the efficiency frontier if its efficiency score is less than 1, which denotes inefficiency. The DEAP version 2.1 program, created by Coelli (1996, 2010), was used to produce the DEA outputs.

Stage Two: Panel Regression Analysis (PRA)

After obtaining DEA efficiency scores (TE, PTE, and SE), the next step is to analyze insurer-specific factors (determinants) that influence the efficiency of insurers (traditional and takaful). Panel regression analysis (like Ming (2020), Cummins, and Xie (2016)) can identify the factors influencing insurers' efficiency in the second stage after measuring the efficiency scores. In the second stage of regression, we first calculate multivariate regression using ordinary least squares (OLS) regression and then perform both the random effect (RE) regression and the fixed effect (FE) regression. The random effect model is preferred over pooled ordinary least squares if the poolability F-test is rejected. Meanwhile, the fixed effect (FE) model is preferred over pooled ordinary least squares (POLS) if the Breusch-Pagan Lagrange (LM) test is rejected. Next, the fixed effect model is selected over the random effect (RE) model if the Hausman test is rejected. The independent variables studied are company size, age, reinsurance, risk, market share, and other indicators (see Table 3). The empirical models that enable investigation of the determinants of efficiency are written as follows:

$$TE_{i,t} = \beta_0 + \beta_1 Size_{i,t} + \beta_2 Age_{i,t} + \beta_3 Reinsurance_{i,t} + \beta_4 Risk_{i,t} + \beta_5 ROE_{i,t} + \beta_6 M.Share_{i,t} + \beta_7 Leverage_{i,t} + \beta_8 Investments_{i,t} + \beta_9 Dtype_{i,t} + \varepsilon_{i,t} \quad \dots (2)$$

$$PTE_{i,t} = \beta_0 + \beta_1 Size_{i,t} + \beta_2 Age_{i,t} + \beta_3 Reinsurance_{i,t} + \beta_4 Risk_{i,t} + \beta_5 ROE_{i,t} + \beta_6 M.Share_{i,t} + \beta_7 Leverage_{i,t} + \beta_8 Investments_{i,t} + \beta_9 Dtype_{i,t} + \varepsilon_{i,t} \quad \dots (3)$$

$$SE_{i,t} = \beta_0 + \beta_1 Size_{i,t} + \beta_2 Age_{i,t} + \beta_3 Reinsurance_{i,t} + \beta_4 Risk_{i,t} + \beta_5 ROE_{i,t} + \beta_6 M.Share_{i,t} + \beta_7 Leverage_{i,t} + \beta_8 Investments_{i,t} + \beta_9 Dtype_{i,t} + \varepsilon_{i,t} \quad \dots (4)$$

Where: $TE_{i,t}, PTE_{i,t}, and\ SE_{i,t}$ represent the efficiency scores (technical, pure technical, and scale efficiency) of insurer i at time t estimated in the first stage, i represents insurers, t represents years and ε represents error term, respectively. With the help of STATA software version, the results of panel regression analysis are reported in this study.

4. Empirical Results and Discussion

Technical, Pure technical, and Scale efficiency

The technical efficiency (TE) of traditional and takaful non-life insurers in Egypt was estimated during the period from 2012 to 2021 using the Data Envelopment Analysis (DEA) method and was divided into pure technical efficiency (PTE) and scale efficiency (SE). Summary statistics for technical efficiency scores are defined in Table 4, pure technical efficiency in Table 5, and scale efficiency in Table 6. As stated above, Table 1 presents technical efficiency (TE) scores measured in terms of constant returns to scale (CRS). The average technical efficiency scores for insurers as a whole (traditional and takaful) range from 69% (2012) to 89% (2020), and from 70% (2012) to 86% (2020) for traditional insurers. It is worth noting that technical efficiency scores were greater than 80% in 2017, 2019, 2020, and 2021; the scores were generally on the rise from 2012 to 2021, except in 2018 and 2021. This suggests that inefficient firms can increase output if they operate at the same efficiency as the most efficient firm in the study sample. On average, the best-performing traditional insurers are the Suez Canal Company and Allianz (91% each), while the least efficient is Misr Company (the only state-owned company with more than a third of the non-life insurance market share).

Table 4: Summary of TE scores from the input-oriented model: 2012-2021

Technical efficiency (TE)											
Insurers	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Misr	0.30	0.30	0.28	0.69	0.82	0.87	0.63	0.66	0.72	0.78	0.61
Suez Canal	0.79	0.75	0.83	0.91	0.96	1.00	0.99	1.00	1.00	0.90	0.91
Mohandes	0.69	0.61	0.66	0.68	0.85	0.82	0.90	0.89	0.93	0.93	0.80
Delta	0.56	0.73	0.71	0.79	0.74	0.74	0.76	0.81	0.81	0.74	0.74
AIG Egypt	0.78	0.86	0.96	0.70	0.62	0.61	0.52	1.00	0.87	1.00	0.79
GIG	0.79	0.74	0.75	0.79	0.74	0.72	0.70	0.69	0.71	0.72	0.74
Chubb	0.68	0.87	0.84	0.94	0.89	0.89	0.52	0.71	1.00	0.66	0.80
Royal	0.79	0.81	0.84	0.94	0.86	0.77	0.84	0.89	0.99	0.95	0.87
Allianz	0.88	0.90	0.85	0.85	0.87	0.93	1.00	0.98	0.94	0.90	0.91
Bupa Egypt	0.73	0.60	0.71	0.76	0.73	0.87	0.81	0.78	0.80	0.80	0.76
Arope	0.82	0.64	0.48	0.56	0.69	0.73	0.82	0.76	0.87	0.72	0.71
Iskan	0.55	0.65	0.76	0.71	0.61	0.77	0.74	0.71	0.70	0.70	0.69
Egy-Saudi	0.84	0.93	0.80	1.00	1.00	0.66	0.91	0.87	0.95	1.00	0.90
Egy-Tak	0.52	0.94	1.00	0.81	0.87	0.80	0.66	0.72	0.98	0.73	0.80
Wethaq Tak	0.61	0.61	0.75	0.78	0.97	0.87	0.83	0.88	1.00	1.00	0.83
Tokio M. Egy	0.68	1.00	0.52	0.67	0.68	0.68	0.78	0.64	0.80	0.79	0.72
Orient Tak	0.66	0.83	0.66	0.74	0.75	0.90	0.90	1.00	1.00	1.00	0.84
Average. Traditional	0.70	0.71	0.72	0.78	0.78	0.81	0.77	0.82	0.86	0.82	0.78
Average. Takaful	0.66	0.86	0.75	0.80	0.85	0.78	0.82	0.82	0.95	0.90	0.82
Average all	0.69	0.75	0.73	0.78	0.80	0.80	0.78	0.82	0.89	0.84	**0.79**

However, on the other hand, the average technical efficiency scores of takaful insurers in Egypt ranged from 66% (2012) to 95% (2020). It is interesting to note that the average technical efficiency scores of takaful insurers have been increasing since 2012, then declining in 2014 and 2017, and then increasing to 95% (2020). This indicates the instability of the average technical efficiency of these operators, it may be due to the infancy of these operators or it may be due to internal and external shocks and they are still not immune to the system, they do not have much resilience and cannot absorb these shocks. Egy-Saudi was the most efficient among the takaful operators, and Tokio M. Egy was the least efficient. However, on average, the average technical efficiency of non-life insurers during the study period was 79%, for traditional companies 78%, and for takaful companies 82%, moreover, all traditional and takaful insurers are producing below the production frontier and are not able to get the optimal level. From Figure (1). In 2012 and 2017, the TE score of takaful insurers was lower than that of traditional insurers, but it equalized in 2019. However, in the remaining years, Takaful insurers outperformed traditional insurers. The figure also suggests that both types of insurers experienced a decline in their technical efficiency in certain years. This could be attributed to the inefficient utilization of their resources. The results of the technical efficiency of the current study are consistent with Keong

(2015) in Malaysia and Benyoussef and Hemrit (2019) in Saudi Arabia and differ with Kamran et al. (2023) in Pakistan.

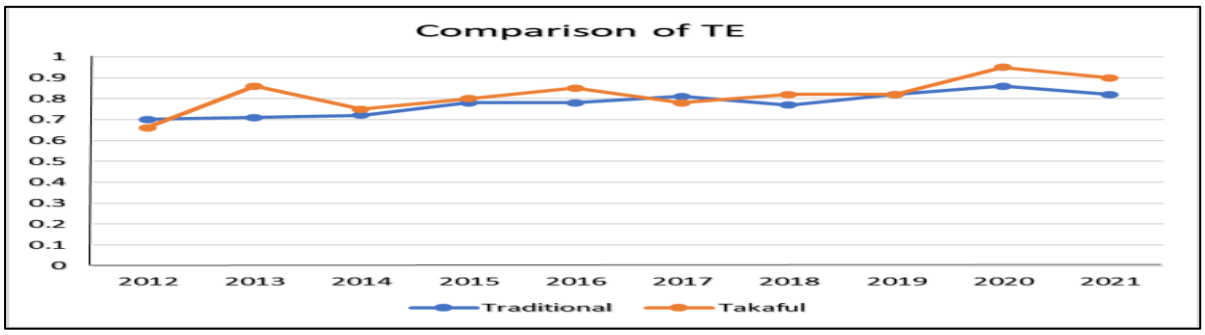

Figure 1: Comparing the technical efficiency (TE) of traditional and takaful insurers

The value of pure technical efficiency (PTE) represents the level of management and decision-making within the insurer or the direct results of poor managerial performance (Alhassan and Biekpe, 2015), and it is the external reflection of the company's internal governance and decision-making ability. Table 5 shows that our insurer's mean value of pure technical efficiency from 2012 to 2021 was 0.82, 0.83, 0.81, 0.84, 0.84, 0.84, 0.83, 0.88, 0.94, and 0.91, respectively. The average PTE for insurers as a whole during the period was 85%, for traditional insurers 85%, and for takaful insurers 87%. Notably, the PTE of Egyptian insurers exceeded their technical level. It is well known that the primary factor limiting the overall efficiency of insurers in Egypt is the low level of technical efficiency (Othman, 2021). This implies that, in comparison to operational decision-making and internal management, the efficiency of the insurer's business and the efforts made to improve the efficiency of insurers hold greater importance. The PTE values of Allianz, Suez Canal, Egypt-Saudi, Wethaq Tak, Orient Tak, and Royal were well above the mean level. Misr and Chubb's pure technical efficiency values were at the top, indicating that over the past 10 years, companies could make sound, forward-looking decisions and good internal governance mechanisms. Meanwhile, the PTE values of Arope and Iskan were significantly lower than the industry mean, indicating that these companies still need to improve their internal management structure and decision-making ability. Scale Efficiency (SE) is an important indicator to measure the insurer's total investment and output and is estimated by the ratio between TE (CRS) and PTE (VRS), which indicates how the company achieves optimal scale. Table 6 shows that from 2012 to 2021, the average scale efficiency of non-life insurers in our study is 0.86, 0.91, 0.90, 0.94, 0.95, 0.96, 0.94, 0.93, 0.95, and 0.93 respectively, and the average overall scale efficiency is 0.93. Takaful insurers recorded average of 0.94 during the entire study period compared to traditional insurers at 0.92. However, the SE scores for both types are unstable.

Table 5: Summary of PTE scores from the input-oriented model: 2012-2021

	Pure Technical efficiency (PTE)										
Insurers	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Misr	1.00	0.93	0.94	1.00	1.00	1.00	0.86	1.00	1.00	1.00	0.97
Suez Canal	0.81	0.77	0.84	0.92	0.97	0.97	1.00	1.00	1.00	0.90	0.92
Mohandes	0.71	0.64	0.69	0.69	0.85	0.83	0.93	0.92	0.98	1.00	0.82
Delta	0.57	0.75	0.73	0.81	0.76	0.75	0.79	0.87	0.89	0.85	0.78
AIG Egypt	0.83	0.89	0.97	0.72	0.64	0.64	0.55	1.00	0.88	1.00	0.81
GIG	0.81	0.75	0.75	0.82	0.76	0.76	0.75	0.74	0.78	0.81	0.77
Chubb	1.00	1.00	0.98	1.00	0.95	1.00	0.78	0.91	1.00	0.83	0.95
Royal	0.79	0.81	0.86	0.96	0.86	0.78	0.84	0.90	0.99	0.98	0.88
Allianz	0.89	0.93	0.88	0.87	0.88	0.94	1.00	1.00	1.00	1.00	0.94
Bupa Egypt	0.74	0.61	0.71	0.80	0.79	0.99	0.92	0.92	0.94	0.96	0.84
Arope	1.00	0.72	0.57	0.60	0.72	0.74	0.83	0.76	0.87	0.72	0.75
Iskan	0.70	0.78	0.82	0.76	0.68	0.81	0.76	0.74	0.72	0.72	0.75
Egy-Saudi	0.90	0.93	0.80	1.00	1.00	0.66	0.91	0.95	1.00	1.00	0.92
Egy-Tak	0.59	0.99	1.00	0.83	0.89	0.81	0.66	0.75	1.00	0.82	0.83
Wethaq Tak	0.75	0.76	0.85	0.86	1.00	0.89	0.83	0.89	1.00	1.00	0.88
Tokio M. Egy	1.00	1.00	0.71	0.83	0.80	0.75	0.82	0.68	0.88	0.85	0.83

Orient Tak	0.78	0.83	0.72	0.78	0.80	0.93	0.92	1.00	1.00	1.00	0.88
Average. Traditional	0.82	0.80	0.81	0.83	0.82	0.85	0.83	0.90	0.92	0.90	0.85
Average. Takaful	0.80	0.90	0.82	0.86	0.90	0.81	0.83	0.85	0.98	0.93	0.87
Average all	0.82	0.83	0.81	0.84	0.84	0.84	0.83	0.88	0.94	0.91	**0.85**

According to Alhassan and Biekpe (2015), who explained that scale inefficiency is due to the company's operation, and not to its management. In addition, SE is directly related to size and technology. Takaful insurers were new to the market and were working to expand the scope of their products and networks. From the perspective of returns to scale, in the study period, most insurers were still in the stage of increasing returns to scale. Therefore, the demand for the insurers market was great. These insurers will continue to expand in the coming period. Misr (state-owned) is in a period of widely declining returns, therefore, this company should not blindly seek to expand the scale, and should work to improve the quality of employees, improve the internal management structure, and strive to achieve more output with current inputs, or bloated employees and organizations must be streamlined to improve the input-output ratio. Suez Canal, Arope, and Orient Tak in the last three years of the study period reached a constant return-to-scale stage. Therefore, these companies' investments and returns were at a critical point. The increase or decrease in returns-to-scale may be influenced by the company's internal management, corporate culture, market environment, and other factors.

Table 6: Summary of SE scores from 2012 to 2021

	Scale efficiency (SE)										
Insurers	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Misr	0.30	0.32	0.29	0.69	0.82	0.87	0.74	0.66	0.72	0.78	0.62
Suez Canal	0.98	0.97	0.98	0.98	0.99	0.99	0.99	1.00	1.00	1.00	0.99
Mohandes	0.97	0.96	0.97	0.99	1.00	0.99	0.97	0.97	0.95	0.93	0.97
Delta	0.98	0.97	0.98	0.98	0.98	0.99	0.97	0.93	0.91	0.88	0.96
AIG Egypt	0.94	0.97	0.98	0.97	0.97	0.96	0.95	1.00	0.99	1.00	0.97
GIG	0.98	0.98	1.00	0.97	0.97	0.95	0.93	0.92	0.91	0.89	0.95
Chubb	0.68	0.87	0.86	0.94	0.93	0.89	0.66	0.78	1.00	0.79	0.84
Royal	1.00	1.00	0.98	0.98	1.00	0.99	1.00	0.99	1.00	0.97	0.99
Allianz	0.99	0.97	0.97	0.97	0.99	0.99	1.00	0.98	0.94	0.90	0.97
Bupa Egypt	0.99	0.99	1.00	0.95	0.93	0.88	0.88	0.85	0.85	0.84	0.92
Arope	0.82	0.89	0.83	0.94	0.96	0.98	0.99	1.00	1.00	1.00	0.94
Iskan	0.79	0.83	0.93	0.93	0.91	0.95	0.97	0.97	0.98	0.98	0.92
Egy-Saudi	0.94	1.00	1.00	1.00	1.00	1.00	1.00	0.92	0.95	1.00	0.98
Egy-Tak	0.88	0.95	1.00	0.97	0.98	0.99	1.00	0.96	0.98	0.89	0.96
Wethaq Tak	0.81	0.81	0.88	0.91	0.97	0.98	1.00	0.99	1.00	1.00	0.94
Tokio M. Egy	0.68	1.00	0.73	0.81	0.85	0.92	0.96	0.94	0.91	0.93	0.87
Orient Tak	0.84	1.00	0.91	0.95	0.94	0.98	0.98	1.00	1.00	1.00	0.96
Average. Traditional	0.87	0.89	0.90	0.94	0.95	0.95	0.92	0.92	0.94	0.91	0.92
Average. Takaful	0.83	0.95	0.90	0.93	0.95	0.97	0.99	0.96	0.97	0.96	0.94
Average all	0.86	0.91	0.90	0.94	0.95	0.96	0.94	0.93	0.95	0.93	**0.93**

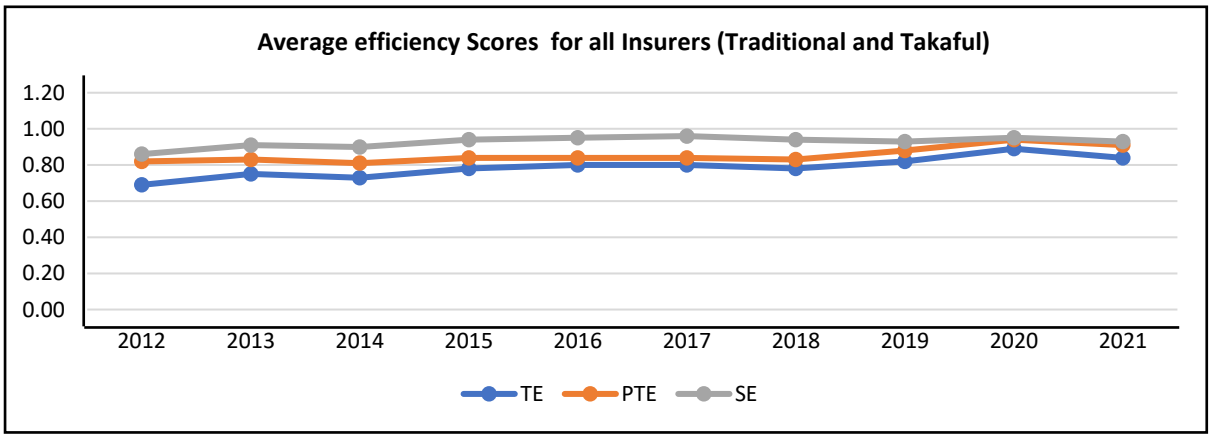

Figure 2: Average Technical, Pure technical, and Scale efficiency scores for all Insurers (2012 – 2021)

The scale efficiency of non-life insurers is higher than pure technical efficiency, indicating that PTE is the primary cause of the overall technical efficiency deficit in the insurance sector. These results reflect that both traditional and takaful insurers may not be allocating their resources (such as capital, labor, and technology) efficiently within their operations; their underwriting policies are ineffective, and scale advantages are not fully realized. The reason may also be market conditions, regulations, and a lack of innovation. Overall, we concluded that the overall scale efficiency of non-life insurers in Egypt was higher than both technical efficiency and pure technical efficiency during the same period and the main problems that limited the efficiency of insurers were the efficiency and effort of employees, and the internal governance of insurers (measured by technical efficiency).

Determinants of Efficiency

Table 7 displays the descriptive statistics for the Stage 2 model. Regarding the insurer-specific factors assumed to explain efficiency differences, the mean growth in the size of insurers' assets (size) is 13.50 percent. The average insurer age (Age) of 24.67 indicates the number of years in operation, while the reinsurance ratio (Reins) of 46.5 indicates a retention rate of 53.5 percent for any business written. The underwriting risk (Risk) of 50.95 also shows that the insurance company pays claims at a rate of 50.9% of its premiums, and the ROE of 20.82 indicates that the insurance company achieves profits on average of 20.8% of equity. The market share (M. Share) of 5.20 indicates that the average insurer's market share is 5.2% of the total market premiums, and the leverage ratio (Lev) of 34.61 also indicates that insurers finance their operations with leverage of 34.6 percent, while investments (Invest) of 25.36 indicate an investment ratio of 25.4% of the insurer's written premiums.

Table 7: The second Stage – Panel regression variables: descriptive statistics

Variables	Size	Age	Rein	Risk	ROE	M.Share	Lev	Invest	Dtype
Mean	13.50	24.67	46.48	50.95	20.82	5.20	34.61	25.36	0.29
Std dev.	1.14	19.18	16.33	13.86	12.54	10.88	12.56	14.67	0.45
Min	11.10	3.00	8.50	0.10	-25.06	0.10	14.45	3.70	0.00
Max	17.45	87.00	83.90	79.90	49.17	58.07	78.54	91.30	1.00
Obs.	170	170	170	170	170	170	170	170	170
Correlation matrix									
Size	1								
Age	0.72****	1							
Reins	0.01	0.10	1						
Risk	0.08	-0.19***	-0.32***	1					
ROE	0.20**	-0.05	-0.07	0.03	1				
M.Share	0.79***	0.75***	-0.08	0.13	-0.07	1			
Leverage	-0.25***	0.03	0.10	-0.40***	-0.35***	0.003	1		
Invest	0.26***	0.28***	0.34***	-0.05	0.17**	0.14*	-0.04	1	
Dtype	-0.19***	-0.49***	-0.05	0.29***	0.11	-0.19**	-0.2**	0.05	1

Note: ***, **, and * denote significance at 1, 5 and 10 percent, respectively.

Before estimating the regression models and to avoid misleading results. The tests on correlation coefficients of the independent variables for multicollinearity have been conducted before the regression analysis; according to Kennedy (2008), the correlation value does not cause a problem unless it exceeds 0.8. So, our results, as shown in Table 7, indicate that multicollinearity in the regression is not a problem. Table 8 shows the results of the relationship between insurers' efficiency (TE, PTE, SE) and the independent variables (insurer-specific factors) selected in the study. We compared the three studied models (POLS, FEM, and REM) for the three types of efficiency using the probability F test, the Breusch-Pagan Lagrange (LM) test, and the Hausman test. We found that the random effects model (null hypothesis rejected) was the best for TE, while the fixed effects model (null hypothesis not rejected) was the best for PTE and SE.

Table 8: Results of Panel regression analysis of insurers' efficiency factors

Variables	Model (1) *TE (REM)*	Model (2) *PTE (FEM)*	Model (3) *SE (FEM)*
Size	0.0290**	-0.0536*	0.0171***
	(0.0127)	(0.0322)	(0.0028)
Age	0.0001	0.0141**	0.0018***
	(0.0010)	(0.0060)	(0.0005)
Reinsurance	-0.0019***	-0.0029***	0.0008***
	(0.0005)	(0.0007)	(0.0002)
Risk	-0.0079***	-0.0061***	-0.0019***
	(0.0006)	(0.0007)	(0.0006)
ROE	0.0016***	0.0006	0.0004
	(0.0006)	(0.0006)	(0.0006)
M.Share	-0.0027*	-0.0053**	0.0059***
	(0.0014)	(0.0024)	(0.0021)
Leverage	-0.0048***	-0.0045***	-0.0020**
	(0.0008)	(0.0012)	(0.0011)
Investments	-0.0028***	-0.0012*	-0.0021***
	(0.0006)	(0.0007)	(0.0006)
Operating type	0.0883***	---	---
	(0.0249)		
Constant	1.0796***	1.8775***	0.7948***
	(0.1753)	(0.3215)	(0.2828)
Obs.	170	170	170
F-statistic		17.96***	8.75***
Wald chi2(9)	273.04***		
R-squared	0.6697	0.4977	0.4694
Adj R-squared	0.6511	0.4694	0.4395
LM-Test	10.34***	3.08***	5.64***
Hausman-Test	14.26	15.69***	45.12***

Source: *Author's calculations. Note: Standard errors are in brackets; ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.*

The results in Table 8 on the determinants of insurers' efficiency revealed the following:
Size: Our regression results show that company size has a positive and significant effect on technical efficiency (β = 0.0290**) and scale efficiency (β = 0.0171***), while it shows a negative effect on pure technical efficiency (β = -0.0536*). Large insurers typically enjoy the economic scale argument due to their ability to determine industry production technology and allocate resources more efficiently. Our findings align with numerous studies on insurance and takaful, including those by Abbas et al. (2018), which found that size positively impacts the efficiency of traditional and takaful insurers in Pakistan, Li et al. (2020) on Chinese non-life insurers, and Cummins and Xie (2016) on US insurers.

Age: The insurer age variable shows a positive and insignificant effect on technical efficiency (β = 0.0001) but is significant on pure technical efficiency (β = 0.0141**) and scale efficiency (β = 0.0018***). Insurers can gain efficiencies by learning through experience and adopting the best technologies available (theory of learning curve). Experienced insurance operators are better able to provide risk-sharing and risk-pooling insurance services. It confirms the hypothesis of positive age efficiency put forward by Jovanovic (1982) and Arrow (1965) but contradicts the results from Bansal and Singh (2021), and Alhassan and Biekpe (2015). The results of our analysis are consistent with the efficiency studies of Biener et al. (2016) and Eyob (2021).

Reinsurance: The reinsurance variable revealed that it is negatively related to technical efficiency (β = -0.0019***) and pure technical efficiency (β = -0.0029***), while it is positively associated with scale efficiency (β = 0.0008***). The negative relationship reflects that insurers in Egypt largely use reinsurance to reduce and diversify risks, and as a result, they share a large proportion of premiums with reinsurers. Regarding the positive relationship between reinsurance and scale efficiency, insurers diversify their risks by ceding their insurance premiums to reinsurance and reinsurance activities. This enhances their risk-bearing capacity,

enabling them to obtain larger amounts of insurance premiums. Our results are consistent with Christian et al. (2015), Alhassan and Biekpe (2015), and Bansal and Singh (2021).

Underwriting risk: It was revealed to be negatively related to technical efficiency (β = -0.0079***), pure technical efficiency (β = -0.0061***), and scale efficiency (β = -0.0019***), indicating that insurers with a high claim's ratio have less efficiency. This result confirms the volatility characteristic of the occurrence of risks, which reduces the operational efficiency of insurers. Although insurers use reinsurance to improve operating conditions in years with sudden risks, doing so also increases operating costs and reduces profits for the company. Therefore, insurers in Egypt must control their claims to achieve optimal performance, as an unprecedented rise in claims could increase the cost of doing business. Empirical research shows that insurers (such as Misr, Arope, and Tokio M. Egy) recorded the highest claims rate during the study period. Consequently, these companies demonstrated the lowest levels of efficiency. Therefore, these companies should review their underwriting processes to reduce the number of claims, thereby enhancing their efficiency. Our results are consistent with Asghar et al. (2018) in Pakistan, while they are inconsistent with Li et al. (2020) in China.

ROE: The results showed that return on equity (ROE) positively affects the TE (β = 0.0016***), PTE (β = 0.0006), and SE (β = 0.0004) for insurers, but only significantly affects the TE. This result suggests that insurance companies with a higher return on equity (ROE) are technically superior, and empirical research showed that insurers that achieved a high return on equity during the study period were more technically efficient especially takaful insurers. Our results are consistent with Jaloudi (2019) and Asghar et al. (2018), while inconsistent with Ashraf (2019) and Li et al. (2020).

Market share It was negatively related to technical efficiency (β = -0.0027*) and pure technical efficiency (β = -0.0053**), while it is positively associated with scale efficiency (β = 0.0059***). The results show that insurers that enjoy market share can be efficient because maintaining a relationship with more customers can increase their efficiency and benefit from cost-sharing and lower costs per unit. On the other hand, the objective of expanding market share could potentially have a detrimental impact on management decisions, as evidenced by the technical efficiency of the company. This suggests that insurers experiencing rapid growth may lack discipline in their underwriting practices and thus attract unfavorable risks. Empirical research has revealed that insurers with a large market share, like Misr, Delta, and the Suez Canal, are less technically efficient compared to smaller companies like takaful insurers. Our findings align with Ashraf's (2019) findings, but they differ from those of Li et al. (2020) and Zhu (2019).

Leverage: Our findings showed that it has a negative and significant relationship with technical efficiency (β = -0.0048***), pure technical efficiency (β = -0.0045***), and scale efficiency (β = -0.0020***). Therefore, high financial leverage leads to lower efficiency, and this does not agree with the free cash flow hypothesis (Jensen and Meckling, 2019). Research on Egyptian insurers like Misr and the Suez Canal that use a lot of financial leverage is less efficient than companies like Orient Tak and Tokio M. Egy that use less leverage. This proves that financial leverage makes a company more efficient at a certain and ideal ratio of equity to assets (Cummins and Nini, 2002). The results of our analysis are consistent with Alhassan and Biekpe (2015), Ming (2020), and Eyob (2021).

Investments: The findings showed that it has a negative and significant effect on technical efficiency (β = - 0.0028***), pure technical efficiency (β = - 0.0012*), and scale efficiency (β = -0.0021***). This result shows that large insurers with a large amount of investments have failed to invest their money at the optimal level, indicating that the larger size raises the cost of doing business. On the other hand, the recent economic crises in my country have led to a decrease in the investments made by large companies. Consequently, we discovered a negative relationship between this variable and the insurer's efficiency. In other words, companies with higher

investments tend to be less efficient, potentially due to their inability to invest as optimally as their smaller counterparts. This result is consistent with Ashraf (2019), while it is inconsistent with Zhu (2019) and Jaloudi (2019).

Operating type: It showed a positive effect on technical efficiency (β = 0.0883***), which indicates that the marginal contribution of takaful insurers is better than traditional in improving the efficiency of the insurance industry in Egypt. Despite being relatively new in the Egyptian market compared to the well-established traditional insurance, takaful insurance quickly emerged as a competitor, as empirical research showed clear efficiency advantages over traditional insurers. Interestingly, the mean scores of TE, PTE, and SE for takaful insurers were 82%, 87%, and 94%, respectively, better than those for traditional insurers, which were 78%, 85%, and 92%, respectively. This result is consistent with Benyoussef and Hemrit (2019), who found the same level of efficiency between traditional and takaful companies, while it is inconsistent with Ming (2020), Bao (2018) in Malaysia, and Kamran et al. (2023) in Pakistan.

5. Conclusions and Recommendations

In this research, we measured and analyzed the efficiency of 17 Egyptian non-life insurers (12 Traditional, 5 Takaful) from 2012 to 2021 using pooled data from 170 observations. We employed a two-stage efficiency model for all empirical investigations, which included panel regression and non-parametric input-oriented D DEA. This paper reached two important findings: First, there is no evidence to suggest that non-life insurers, both traditional and takaful, consistently enhance their efficiency over time using the input-output mix method. On average, companies achieved a technical efficiency level of 79%. By effectively managing the mix of inputs and outputs in the current DEA model, we can still enhance efficiency in this industry by 21%. For example, to move in the efficiency frontier, insurance companies need to carefully reconsider their input surpluses and output shortages. Also on average, across the two types of insurers, traditional insurers obtained a technical efficiency level of 78%, and takaful insurers achieved a technical efficiency level of 82%. Based on these findings, the Egyptian Financial Regulatory Authority (EFRA) should focus on the following: (a) reviewing the underwriting and investment policies of insurers, studying the causes of inefficiency, and working to address them; (b) improving the quality of current activities, information technology, and risk management in companies; (c) training and developing staff, raising their skills, and improving customer service in companies; (d) implement expansion strategies and streamline operations to reduce time and effort using modern technologies; and (e) improving the internal management structure of companies, and improving the professional quality of staff, to use current inputs to achieve more outputs. In the long run, this can help improve the efficiency of companies in the industry. Second the second-stage analysis (determinants of efficiency) revealed that factors such as type of operation, size, return on equity (ROE), and age positively influence insurers' efficiency, whereas variables such as reinsurance, claims (risk), market share, leverage, and investments negatively impact these insurers. The findings of this paper provide useful insights into the organization and management of non-life insurers (traditional and takaful) in Egypt. By identifying the important determinants of efficiency in the non-life insurance market in Egypt, this paper provides insurance management with relevant indicators that will guide them toward the effective use of their resource base and improve their operational efficiency.

6. Limitations and Future Research Directions

Although this research offers valuable insights into the efficiency (TE, PTE, SE) of insurers of both types and their determinants, it should acknowledge several limitations. First, the study focused on non-life insurers; second, it used the non-parametric approach (DEA); third, it focused on insurer-specific factors as determinants of efficiency. This research can be improved in many ways. Further research can evaluate the cost-profit efficiency of the non-life insurance industry to identify inefficiencies in terms of cost and revenue. Standard econometric methods for estimating efficiency such as SFA can also be used to examine efficiency for comparative purposes. Finally, an obvious step involves replicating this study in the life insurance market.

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