International Journal of Science and Business 2024, 42(1), 121-137
ISSN: 2520-4750 (Online) 2521-3040 (Print)
Journal: ijsab.com/ijsb

Determinants of Productivity of Conventional and Takaful Non-Life Insurers in Egypt: A Two-Stage Malmquist Productivity Index

Maher Abdellatif [1*], Yuantao Xie [2], Rady Hussein [1], & Doaa Hasaballa [1]

[1] Faculty of Commerce, Assiut University, Assiut 71515, Egypt.
[2] School of Insurance and Economics, University of International Business and Economics, Beijing 100029, China.
* Corresponding author: Maher Abdellatif (maher.842020@gmail.com)

Abstract

This research aims to analyze total factor productivity and the determinants influencing the productivity of conventional and takaful non-life insurers in Egypt from 2012 to 2021. We used a two-stage Malmquist productivity index to analyze panel data from 17 non-life insurers of both types. The first stage investigated total factor productivity (TFP) utilizing the Malmquist productivity index (MPI) technique of the DEA model. The second stage utilized panel regression analysis to discover the insurer-specific factors influencing productivity. The findings indicate that TFP in the Egyptian non-life insurance sector has progressed by 5% per year from 2012 to 2021. However, the TFP experienced a decrease in 2014 and 2018, with negative growth rates of 3% and 2%, respectively. The decomposition of TFP reveals that technological change (Tch) primarily accounts for overall progress. The change in technical efficiency (EFFch) negatively impacts TFP. Furthermore, on average, takaful insurers showed higher TFP compared to conventional insurers. The findings also showed that the variables of insurer size, reinsurance, insurer age, claims rate, leverage, market share, and operational type significantly influence the growth of total factor productivity for Egyptian non-life insurers. As far as we know, this study is the first empirical evidence for both types of non-life insurers in Egypt regarding estimating TFP and its influencing factors. Consequently, this study will assist policymakers and both conventional and takaful insurers in formulating effective policies aimed at enhancing insurer productivity in Egypt.

Keywords: *Total Factor Productivity, Malmquist index, Takaful, Conventional, Egypt.*

ARTICLE INFO

Research paper
Received: 12 August 2024
Accepted: 30 October 2024
Published: 6 November 2024
DOI: 10.58970/IJSB.2488

CITATION

Abdellatif, M., Xie, Y., Hussein, R., & Hasaballa, D. (2024). Determinants of Productivity of Conventional and Takaful Non-Life Insurers in Egypt: A Two-Stage Malmquist Productivity Index, *International Journal of Science and Business*, 42(1), 121-137.

COPYRIGHT

*Copyright © **2024** by author(s) Papers published by IJSAB International are licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.*

1. Introduction

The insurance industry is a vital economic sector that is important in enhancing economic stability and supporting financial development. Among the different types of insurance, non-life insurance is gaining special attention in the financial markets, as it covers a wide range of risks, including property, accident, and health insurance (Nourani et al., 2022). In Egypt, non-life insurers have witnessed significant developments in recent years, with increasing awareness of the importance of these products and their role in protecting individuals and companies (Taha, 2024).

Egypt has adopted a dual insurance system, where conventional and takaful insurance work together. Beginning in 2003, the takaful industry in Egypt is considered to be in the early stages of the market. Due to competition from well-established conventional insurance and economic fluctuations, it is currently struggling to maintain profitability (Abdellatif & Xie, 2024). Non-life insurers differ between conventional (commercial) and takaful companies, as the former rely in their operations on maximizing profits, while takaful insurers rely on the principles of cooperation and solidarity among members, which contribute to a more equitable distribution of risks and reflect the social values of individuals (Ming, 2020). These differences are evident in productivity and performance strategies (Sukmaningrum et al., 2023), which makes it necessary to study the efficiency of these companies in achieving their production goals.
The non-life insurance industry's rapid development in recent years has become a key driver of Egypt's overall economic expansion. For a long time, the Egyptian insurance industry has continuously used a large-scale business approach, prioritising speed above quality (Othman, 2021). The market is quite competitive for Egyptian insurers. It has become clear that increasing total factor productivity gradually is essential to the steady functioning and long-term growth of Egypt's non-life insurance industry. Therefore, it is crucial to examine the elements that affect the total factor productivity (TFP) of Egyptian non-life insurers and to systematically evaluate it. Productivity is regarded as one of the primary indicators of an insurer's competitiveness and is the most important component in evaluating its performance (Abu Assi, 2022). Superior productivity results from consistent inputs and improved output (Alhassan & Biekpe, 2015). In addition to analysing productivity, insurers need to determine the elements that affect their output.

The entire production efficiency of production units, mostly businesses, as distinct system components is known as total factor productivity (TFP). In order to give a dynamic performance analysis, frontier efficiency studies frequently examine total factor productivity (TFP). According to Cummins and Weiss (2013), the terms efficiency and total factor productivity (TFP) are connected. TFP is computed by dividing the entire quantity of output generated by the total number of inputs used (Freire et al. 2008). TFP is determined by how well firms use the finest manufacturing technologies available. Consequently, efficiency and technology are the two primary drivers of improvements in total factor productivity (TFP). Efficiency change is driven by a firm's efficiency index in comparison to its past and present frontiers, whereas technical change is driven by a change in the production frontier. Both econometric and mathematical programming techniques are typically used to evaluate changes in total factor productivity (TFP). The most often used technique is the data envelopment analysis (DEA) model-based Malmquist index approach.

The effectiveness of insurers has drawn the attention of international academics. The primary focus of early writing was on insurer efficiency from the standpoint of economies of scope and scale. Segal (2003) used the transcendental logarithmic cost function technique to analyse the size and economies of scale of the U.S. life insurance market. According to his research, economies of scale are often seen in the life insurance market in the United States. Cummins et al. (2010) conducted a cost efficiency analysis of the US insurance business from 1993 to 2006 and found that only the property insurance market's cost efficiency was able to reach economies of scope. However, the majority of recent foreign literature has focused on estimating total factor productivity (TFP) using the DEA-Malmquist method, whether at the country level (Lim et al., 2021; Abu Assi, 2022; Nourani et al., 2022; Wanke & Barros, 2016; Alhassan & Biekpe, 2015) or at the level of specific countries (Al-Amri et al., 2021; Eling & Jia, 2019; Abdul Kader et al., 2014; Huang & Eling (2013)). Moreover, Ming (2020), Cummins & Xie (2016), Sun (2020), and Sukmaningrum et al. (2023) examined the factors affecting the total factor productivity (TFP) of insurers in Malaysia, the United States, China, and Indonesia, respectively. Most of the studies that have been done in Egypt so far, like Taha (2024), Othman (2021), Hafez & Hassan (2020), Saeed (2018), and Abdellatif & Xie (2024), have looked at how efficient traditional and takaful insurers

are without actually looking into the total factor productivity (TFP) of insurers. While numerous foreign studies have extensively examined the factors influencing the total factor productivity (TFP) of both conventional and takaful insurers, no study in Egypt has conducted an empirical investigation into these factors. Therefore, this research aims to contribute new empirical findings to the expanding body of studies on productivity analysis and the factors influencing it.
This study adds to the body of literature in a number of ways: First off, this is the first study that we are aware of that examines the effectiveness of both traditional and Takaful non-life insurance in Egypt. Therefore, by comparing the efficiency and total factor productivity of the two forms of insurance in Egypt's emerging non-life insurance markets, our research adds to the body of knowledge on efficiency comparison in insurance. Second, the comparison of the two insurance kinds shows the dynamic trend of the non-life insurance market's efficiency in addition to revealing the features of each type's relative efficiency. This helps us better understand the causes of the two insurance kinds' disparate levels of efficiency. Furthermore, an evaluation of the effectiveness of non-life insurance development at the level of Egypt's two insurer types is a crucial resource for pertinent stakeholders to create business and growth plans. Third, researching and analysing the insurer-specific factors (determinants) that affect non-life insurers' productivity is a valuable resource for stakeholders looking to enhance their operational systems and productivity.

This research serves as a factor that non-life insurers should consider when managing resources to achieve optimal performance. In addition, companies should prioritize productivity and focus on the factors that impact growth. We rarely research the productivity of conventional and takaful non-life insurance and the factors that govern it, so this study provides an opportunity to further explore this issue. According to the aforementioned, this research seeks to:

1. Measure and evaluate the total factor productivity (TFP) and its components for conventional and takaful non-life insurers in Egypt.
2. Identify the factors (insurer-specific factors) that affect productivity in conventional and takaful non-life insurers.

The remainder of the research is divided into five sections. The literature review section highlights studies that have examined productivity and its influencing factors (insurer-specific factors), both locally and abroad. The research methodology section, data sources, and empirical models come next, followed by the section on empirical results and analysis. Finally, the conclusion and recommendations end with recommendations for further research based on the limitations of the research.

2. Literature Review

The two main categories of approaches used in current research on insurers' efficiency evaluation are parametric approaches based on stochastic frontier analysis (SFA) and non-parametric approaches based on data envelopment analysis (DEA) (Abdellatif & Xie, 2024). The classic DEA approach has been improved by the newly popular DEA-Malmquist index methodology (Reyna et al., 2022; Lim et al., 2021; Ferro & León, 2018; Altuntas et al., 2021; Biener et al., 2016). Non-parametric approaches are better equipped to track the development of non-life insurance market efficiency as parametric approaches rely too much on parametric hypotheses and the standard DEA method does not capture dynamic features. Research has been focused on evaluating the non-life insurance market's efficiency since the 1990s. Ferro and León (2018) assessed Argentina's nonlife insurers' technical effectiveness. The overall factor productivity of Indian commercial and public non-life insurers was analysed and contrasted by Venkateswarlu and Rao (2019). Yu et al. (2021) evaluated the non-life insurance industry's productivity across Chinese provinces and discovered that improvements in both pure technical and scale efficiency are the cause of the rise in TFP. The productivity of Malaysia's life and non-life insurance industries was assessed by Lim et al. (2021), who came to the conclusion that shifts in technological efficiency were to blame for the decline in total factor productivity. The cost-efficiency levels and variations across non-life insurers of different sizes were examined by

Cummins and Weiss (1993). According to their research, the average efficiency of small, medium, and big insurers was around 88%, 80%, and 90%, respectively. They also discovered that small and medium-sized insurers had more room to cut expenses. After examining the technical, pure technical, scale, allocative, and cost efficiency of 46 Australian non-life insurers, Worthington and Hurley (2002) came to the conclusion that allocative inefficiency was the main cause of inefficiency. The effectiveness and productivity of the Swiss insurance market, which includes the life, non-life, and reinsurance sectors, were assessed by Biener et al. (2016). The results showed that although the life insurance sector of the Swiss insurance business was unchanged, only the reinsurance and non-life sectors showed increases in productivity and efficiency. The impact of mergers and acquisitions on productivity and efficiency in the non-life insurance sector in the United States was examined by Cummins and Xie (2008). The productivity and efficiency of the German non-life insurance market were thoroughly examined by Luhnen (2009). The market might boost technical efficiency by around 20 percentage points and cost efficiency by about 50 percentage points. The rise in TFP was low, and efficiency growth was modest. Additionally, Altuntas et al. (2021) studied the profitability, revenue, cost effectiveness, and productivity of 84 insurers in the German non-life insurance market. Yaisawarng et al. (2014) looked into economies of scale and technical advancements in Thailand's non-life insurance market. Alhassan and Biekpe (2015) conducted a thorough analysis of the productivity, efficiency, and returns to scale in the non-life insurance industry in South Africa. Their findings showed that over 50% of non-life insurers were inefficient, with only 20% of insurers functioning at their ideal size. However, several studies have looked at the productivity of life and non-life insurers for a set of nations using the DEA-Malmquist approach. The productivity of 1616 life and non-life insurers across 91 countries was investigated by Eling and Jia (2019). The productivity of 125 life and non-life insurers in 16 Middle East and North Africa (MENA) nations was examined by Shaddady (2022).

Several researchers have sought to evaluate the efficiency of takaful insurance. Ali et al. (2021) employed the DEA technique to assess the technical efficiency of 41 takaful insurers across 16 countries. The analysis revealed that Takaful insurers in Egypt, Pakistan, Bangladesh, and Yemen demonstrated a higher level of performance relative to their counterparts in other countries within the sample. Bao et al. (2018), Rahman (2015), and Akhtar (2018) conducted a comparative analysis of the efficiency and productivity of conventional and takaful insurers in Malaysia, Bangladesh, and Saudi Arabia. Their findings indicate that takaful insurers show lower efficiency and productivity levels compared to their conventional counterparts. Singh and Zahran (2013) performed a detailed examination of the cost efficiency of various types of insurers in eight countries within the Middle East and North Africa region. The analysis revealed that Takaful insurers exhibit lower efficiency compared to their conventional counterparts. There have been studies that look at the factors that affect efficiency and productivity for both conventional insurers (Ilyas & Rajasekaran (2019); Lee et al. (2019); Li et al. (2020); Jaloudi (2019); Sun (2020); Cummins & Xie (2016); Zhu (2019)) and Takaful Insurers (Sukmaningrum et al. 2023). Other studies have looked at both types of insurers (Ming (2020); Ashraf (2019); Bansal & Singh (2021); Benyoussef & Hemrit (2019); Abdellatif & Xie (2024); Abbas et al. (2018). Many works of Egyptian literature, including Murad (2021), Othman (2021), Hafez (2022), Taha (2024) on conventional insurers, Saeed (2018) on takaful insurers, and Abdellatif & Xie (2024) on both conventional and takaful insurers, have evaluated the efficiency of insurers in Egypt. However, no study specifically examined the total factor productivity of life or non-life insurers, whether traditional or takaful. Although many foreign studies have performed comprehensive empirical analyses on the determinants of total factor productivity in financial institutions, including banks and insurers of both types (conventional and takaful), there has been a lack of empirical research in Egypt focusing on the factors influencing the total factor productivity of insurers.

3. Research Methodology

3.1 Data and Sample

The research utilized secondary data collected from the financial statements of non-life insurers in Egypt for the period 2012–2021, sourced from the Financial Regulatory Authority's statistical yearbook on the Egyptian insurance market. Twelve conventional and five takaful non-life insurers represent the sample, which includes Misr (state-owned), Suez Canal, Delta, Mohandes, AIG, Royal, Allianz, GIG, Chubb, Bupa, Iskan, Arope, Egyptian Saudi, Wethaq takaful, Egyptian takaful, Orient takaful, and Tokio Marine. These insurers account for over 85% (in terms of premiums) of the non-life insurance market share. Although the takaful insurers began operations in 2003, all five of them fully began operations in 2012. We chose the period for this reason.

3.2 Choose Input - Output and Determinants of Productivity

This research employs the DEA-Malmquist index model to measure and evaluate the changes and causes of efficiency for conventional and takaful non-life insurers in Egypt. Because insurers' production and operational systems are very different from those of other businesses, it is important to select the right input and output indicators to figure out the total factor productivity (TFP) of Egyptian non-life insurers. The calculation of total factor productivity (TFP) in the financial sector involves three methods for selecting input and output indicators: the value-added, the user cost, and the asset (intermediate) method. Research from both domestic and foreign researchers, including Ashraf (2019), Ming (2020), Kamran et al. (2023), Taha (2024), and Murad (2021), indicates that the asset (intermediate) method is the most suitable approach for studying the TFP of insurers. In this research, we selected general and management expenses, equity, and net claim incurred as input variables, aligning with the findings of previous studies by Keong (2015), Al-Amri (2015), Biener et al. (2016), Ashraf (2019), Ming (2020), Bao et al. (2018), and Taha (2024). We also collected premiums or contributions and net investment income as output variables, aligning with the findings of previous studies by Alhassan & Biekpe (2015), Al-Amri et al. (2021), Biener et al. (2016), Ming (2020), and Murad (2021), while considering the significance of these indicators and the availability of data. Table 1 provides details of the selected input and output indicators. In addition, Table 2 shows the descriptive statistics of the input and output indicators used to study the total factor productivity of non-insurance insurers (conventional and takaful).

Table 1: Selected input-output indicators

Indicators		Indicators definition
Input indicators	General & management expenses	Includes general & management expenses and commissions paid at the end of the year.
	Equity	It is the net assets of the company, and is defined as the remaining value of the firm's assets after its liabilities are subtracted.
	Net claim incurred	Represents the outstanding claims at year-end plus claims disbursed during the year, subtracting the outstanding claims at the beginning of the year.
Output indicators	Premiums or contributions	Refers to the total amount of premiums collected or written by an insurance firm during the year from policyholders.
	Net investment income	Annual net income from financial investing operations.

Source: *Authors' compilation from insurers' annual reports.*

Table 2: Summary statistics of input-output indicators

	Input indicators			Output indicators	
	General & management expenses	**Equity**	**Net claim incurred**	**Net investment income**	**Premiums or contributions**
Mean	7.35	84.85	20.86	10.48	37.44
S. deviation	14.94	291.61	48.41	25.32	85.67
Maximum	85.03	1898.23	336.13	143.66	546.67
Minimum	0.03	1.57	0.02	0.17	1.16
Obs	170	170	170	170	170

Source: *Authors' calculations using STATA software; Field data collection, the annual statistical book of the Egyptian insurance market; Note: Values are in Million EGP (Egyptian pound).*

Table 3 shows the independent variables (insurer-specific factors) and their actual and expected relationships with the TFP, as reported in the studies by Nourani et al. (2018), Ming (2020), Bansal & Singh (2021), Ashraf (2019), Kamran et al. (2023), and Gharaei et al. (2020).

Table 3: Relevant Independent Variables and Definitions

Insurer-specific factors (determinants)	**Symbol**	**Measure**	**Expected Relation**	**Actual Relation**
Insurer size	Size	Logarithm of total assets.	±	-
Insurer age	Age	Number of years since the establishment of the insurer in Egypt.	±	-
Reinsurance	Rein	Premiums ceded to the reinsurer. (%)	±	+
Claims rate	Risk	Net claims / net premiums. (%)	-	-
Return on equity	ROE	Profit before tax / equity. (%)	+	-
Return on investment	ROI	Investment income / premium income. (%)	-	+
Market share	M.S	The premium of each insurer to the total premiums.	±	+
Leverage	Lever	The equity to total assets. (%)	-	-
Operating type	Dtype	A dummy variable. 1 = takaful insurer; 0 = traditional insurer	+	+

Source: *Prepared by the authors.*

3.3 Method

Two-Stage Malmquist Productivity Index

The study employed a two-phase methodology. In the first step, the Malmquist Productivity Index (MPI) is used to assess the productivity levels of both traditional and takaful non-life insurers. In contrast, the second step looks at how insurer-specific characteristics impact productivity using a panel regression model.

First stage: DEA-Malmquist Index Analysis Model

This research employs the DEA-Malmquist index model (Färe et al., 1994) to examine the dynamic changes and causes of operational efficiency in conventional and takaful non-life insurers in Egypt. The DEA-Malmquist index model is selected for two primary reasons. Firstly, as a non-parametric model, it avoids the issues associated with stochastic frontier analysis (SFA) and other methodologies that depend heavily on parameter assumptions. Secondly, it can partition overall efficiency into different efficiencies to enhance understanding of the dynamic evolution of efficiency and its main causes. The Malmquist index is based on the idea of the production function, which estimates the maximum production function with limited inputs, and the construction of the index includes different outcomes: total factor productivity change (TFPch), efficiency change (EFFch), technological change (Tch), pure technical efficiency change (PTEch), and scale efficiency change (SEch) (Sun et al., 2012). Due to the difficulties of achieving constant returns to scale (CRS) in practice (Coelli et al., 2005), the research utilizes the BCC-DEA model under the assumption of variable returns to scale (VRS). The formulation for this model is as follows:

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

subject to:

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

The model mentioned above estimates the efficiency of each DMU based on input orientation, whereas the objective function reflects overall efficiency by focusing on input minimization, where X_{ij} it means the amount of the i^{th} input (general and management expenses, equity, and net claims incurred) at DMU_j (conventional and takaful insurers); Y_{rj} means the amount of the r^{th} output (Premiums or contributions, and net investment income) at DMU_j; 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. The BCC-DEA model is limited to comparing the efficiency values of various decision-making units within the same period and is unable to measure changes in efficiency values across different periods. To achieve this objective, it is needed to apply the Malmquist index (Farrell, 1957), which is described as follows:

$$TFPch = MPI(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{d^t(x^{t+1}, y^{t+1})}{d^t(x^t, y^t)} * \frac{d^{t+1}(x^{t+1}, y^{t+1})}{d^{t+1}(x^t, y^t)}\right]^{\frac{1}{2}} \dots\dots\dots\dots\dots\dots (2)$$

Where (x^t, y^t) and(x^{t+1}, y^{t+1}) stand for the input and output of the period t and $t+1$, respectively; $d^t(x^t, y^t)$ and $d^t(x^{t+1}, y^{t+1})$, respectively, denote the distance function of decision units in the t period and t+1 period with data in the t period as the reference set; and $d^{t+1}(x^t, y^t)$ and $d^{t+1}(x^{t+1}, y^{t+1})$, respectively, denote the distance function of decision units in the t period and t+1period with the data in the $t+1$period as the reference set. When the Malmquist index exceeds 1, it improves efficiency, stays unchanged when it equals 1, and indicates decreased efficiency when it falls below 1.

This research abbreviates the efficiency of total factor productivity as TFPch. The technical progress index (Tch) and technical efficiency change index (EFFch) can be further decomposed from TFPch as follows (Fare et al., 1994):

$$MPI(x^{t+1}, y^{t+1}, x^t, y^t) = \underbrace{\frac{d^{t+1}(x^{t+1}, y^{t+1})}{d^t(x^t, y^t)}}_{EFFch} \underbrace{\left[\frac{d^t(x^{t+1}, y^{t+1})}{d^{t+1}(x^{t+1}, y^{t+1})} * \frac{d^t(x^t, y^t)}{d^{t+1}(x^t, y^t)}\right]^{\frac{1}{2}}}_{Tch} \dots\dots\dots (3)$$

Furthermore, the EFFch in equation (3) can also be divided into pure technical efficiency change (PTEch) and scale efficiency change (SEch) by adding variable returns (VRS) to the scale distance function. which can be defined as follows (Yu et al., 2021):

$$EFFch = \frac{d^{t+1}(x^{t+1}, y^{t+1})}{d^t(x^t, y^t)} = \underbrace{\frac{d_{VRS}^{t+1}(x^{t+1}, y^{t+1})}{d_{VRS}^t(x^t, y^t)}}_{PTEch} * \underbrace{\frac{d_{VRS}^{t+1}(x^{t+1}, y^{t+1})\ d_{CRS}^{t+1}(x^{t+1}, y^{t+1})}{d_{VRS}^{t+1}(x^t, y^t)\ d_{CRS}^t(x^t, y^t)}}_{SEch} \dots\dots (4)$$

Where (VRS) and (CRS) denote the variable returns to scale technology and the constant returns to scale technology, respectively. Thus, the formula for calculating TFPch is as follows:

$$TFPch = EFFch * Tch = PTEch * SEch * Tch \dots\dots\dots\dots\dots\dots\dots\dots\dots (5)$$

Where TFPch denotes total factor productivity, while EFFch indicates the technical efficiency change, which measures the extent of input wastage for each factor. Tch is the technological progress, which shows the advancement and enhancement of science, technology, and operational processes in the company to align with future market conditions. SEch denotes the scale efficiency index, which indicates the impact of scale factors on TFP, while PTEch indicates the pure technical efficiency change, representing the production efficiency of a company influenced by technological and management factors. Therefore, the DEA-Malmquist model can help the obtaining of more dynamic and complete connotative information in the evaluation of the efficiency of Egypt's conventional and takaful non-life insurers.

Second stage: Panel Regression model

To assess the total factor productivity (TFP) of Egyptian conventional and takaful non-life insurers, we should not only estimate the total factor productivity of 17 Egyptian conventional and takaful non-life insurers but also examine the insurer-specific factors that influence these companies' total factor productivity to urge the management of these companies to pay attention to these factors in the future and continuously enhance the total factor productivity of Egyptian conventional and takaful non-life insurers. Relevant foreign studies by Ming (2020), Bansal & Singh (2021), Ashraf (2019), Sukmaningrum et al. (2023), and Kamran et al. (2023) indicate that insurer-specific factors, such as insurer size, insurer age, reinsurance, claims rate, return on investment, return on equity, leverage, market share, and operating type, primarily affect the total factor productivity of insurers of both types.

Table 3 displays the relevant variables and their definitions. Based on the above first-stage analysis, the second stage of this research uses total factor productivity (TFP) as the dependent variable and nine variables (insurer-specific factors) as the independent variables to construct a panel data regression model. Panel data models are generally divided into three types: ordinary least squares regression (OLS), random effect regression (RE), and fixed effect regression (FE). This research will select the random effect regression (RE) model, after the F test, Breusch-Pagan Lagrange (LM) test, and Hausman test results. The empirical model that enables the investigation of the determinants of total factor productivity can be written as follows:

$$TFP_{i,t} = \beta_0 + \beta_1 Size_{i,t} + \beta_2 Age_{i,t} + \beta_3 Rein_{i,t} + \beta_4 Risk_{i,t} + \beta_5 ROE_{i,t} + \beta_6 M.S_{i,t} + \beta_7 Lever_{i,t} + \beta_8 ROI_{i,t} + \beta_9 Dtype_{i,t} + \varepsilon_{i,t} \quad \ldots\ldots \quad (6)$$

Where $TFP_{i,t}$ represent the total factor productivity value of insurer i at time t estimated in the first stage; i represents insurers; t represents years; ε represents error term, respectively; β_0 and β_i are the parameters to be estimated for each independent variable. With the help of *STATA* software version, the results of panel regression analysis are reported in this research.

4. Results and Discussion

Measurement TFP of Egyptian conventional and takaful non-life insurers

In the first-stage analysis, the research computes the annual mean TFP of the Egyptian non-life insurance sector from 2012 to 2021, utilizing statistical data from 17 conventional and takaful non-life insurers, and Malmquist index (MPI) analysis of the DEA model, using DEAP 2.1 software. Table 4 shows specific findings. Table 4 indicates that Chubb holds the highest total factor productivity among the sample companies (1.26), while Misr (stat-owned) exhibits the lowest (0.96). The mean total factor productivity for non-life insurers is 1.05, while conventional non-life insurers have a productivity of 1.04, which is lower than that of takaful non-life insurers at 1.08. Chubb has the highest total factor productivity (1.26) among conventional insurers, while Misr has the lowest total factor productivity (0.96). In contrast, Orient Tak has the highest total factor productivity (1.16) among takaful insurers, while Tokio M. Egy has the lowest total factor productivity (1.02).

Table 4: Decompose of TFP of conventional and takaful non-life insurers in Egypt (2012 - 2021)

NO	Insurers	Efficiency Change (EFFch)	Technological Change (Tch)	Pure Technical Efficiency Change (PTEch)	Scale Efficiency Change (SEch)	Total Factor Productivity (TFPch)
1	**Misr**	1.00	0.96	1.00	1.00	0.96
2	Suez Canal	1.00	1.01	1.00	1.00	1.01
3	Mohandes	1.00	1.04	1.00	1.00	1.04
4	Delta	1.02	1.00	1.02	1.00	1.03
5	AIG Egypt	1.00	1.18	1.00	1.00	1.18
6	GIG	0.99	1.01	1.00	0.99	1.00
7	Chubb	1.01	1.24	1.00	1.01	1.26
8	Royal	1.00	0.99	1.00	1.00	1.00
9	Allianz	1.00	1.01	1.00	1.00	1.01
10	Bupa Egypt	1.00	1.00	1.00	1.00	1.00
11	Arope	0.98	1.01	1.00	0.99	0.99
12	Iskan	1.02	1.02	1.00	1.02	1.04
13	**Egy-Saudi**	1.00	1.08	1.00	1.00	1.08
14	Egy-Tak	0.98	1.11	1.00	0.98	1.09
15	Wethaq Tak	1.00	1.06	1.00	1.00	1.06
16	Tokio M. Egy	0.99	1.03	1.00	0.99	1.02
17	Orient Tak	1.01	1.15	1.00	1.00	1.16
Mean. Conventional		1.00	1.04	1.00	1.00	1.04
Mean. Takaful		0.99	1.09	1.00	0.99	1.08
Mean all		1.00	1.05	1.00	1.00	1.05

Source: *Authors' calculations using DEAP2.1 software.*

The table indicates that the main reason for the comparatively elevated total factor productivity (TFPch) of most non-life insurers in the study sample is technological progress (Tch) surpassing their technical efficiency change (EFFch), whether at the level of each insurer or the insurers as a whole. This indicates that the drive for technological advancement among Egyptian non-life insurers significantly contributes to enhancing total factor productivity (TFP), while the impact of comprehensive management and technical level represents a negative impact. In addition, Figure 1 indicates that most non-life insurers, whether conventional or takaful, showed an average increase in TFP during the study period, except for Misr and Arope, which showed a decrease. Our research's results differed from Rahman (2015) in Bangladesh, which indicated that the TFP of conventional insurers surpassed that of takaful insurers, while aligning with Keong (2015) in Malaysia, who reported an improvement in TFP for both conventional and takaful insurers, and Ashraf (2019) in in Pakistan.

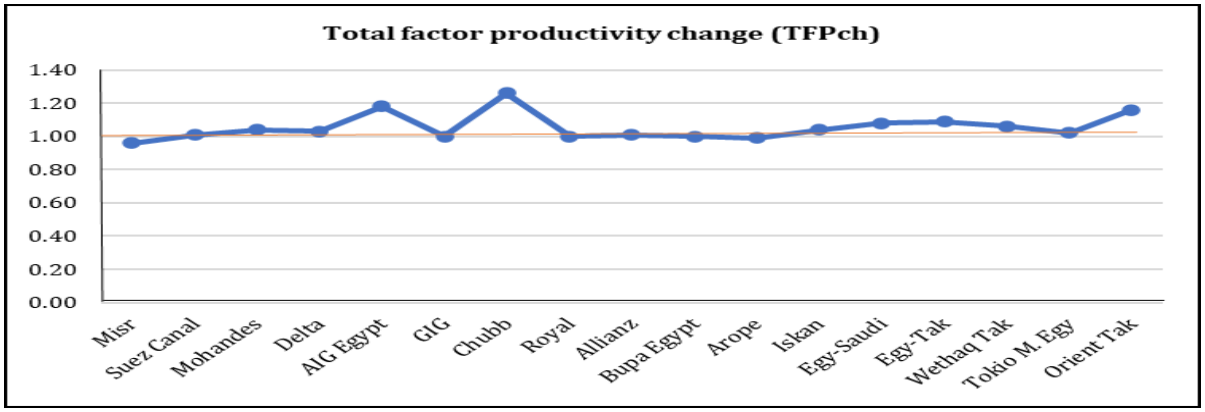

Figure 1: Overall trend of TFP for conventional and takaful non-life insurers in Egypt (2012-2021)

Table 5, and Figure 2 show a detailed analysis of the decomposition and change of the mean TFP of Egyptian non-life insurers during the period from 2012 to 2021. The mean total factor

productivity of non-life insurers from the time series data for the period 2012-2021 is 1.05, showing a trend of declining first and then rising. From 2012 and 2021, the mean TFP exhibited a declining trend, primarily attributed to a significant reduction in the technical efficiency change (EFFch). In 2019 and 2020, there was a notable rise in the mean TFP, attributed to a significant improvement in the technical efficiency change through that period. In general, the mean value of the technical efficiency comprehensive change (EFFch) was 1, indicating stability, while the technological progress (Tch) exceeded 1 during the study period. This denotes that the technological progress played a significant role in increasing the mean value of the growth rate of total factors during the study period.

Table 5: TFP change indicators for the Egyptian conventional and takaful non-life insurers (2012 - 2021)

Year	Efficiency Change (EFFch)	Technological change (Tch)	Pure Technical Efficiency Change (PTEch)	Scale Efficiency Change (SEch)	Total Factor Productivity (TFPch)
2012-2013	1.01	1.15	1.01	1.00	1.16
2013-2014	1.00	0.97	1.00	1.00	0.97
2014-2015	0.99	1.01	0.98	1.01	1.00
2015-2016	0.99	1.05	1.02	0.97	1.04
2016-2017	1.01	1.03	0.99	1.02	1.04
2017-2018	0.98	1.01	0.98	1.00	0.98
2018-2019	1.03	1.13	1.04	0.99	1.17
2019-2020	1.01	1.06	1.00	1.01	1.07
2020-2021	0.99	1.06	1.00	0.99	1.04
Mean. Conventional	1.00	1.04	1.00	1.00	1.04
Mean. Takaful	0.99	1.09	1.00	0.99	1.08
Mean all	1.00	1.05	1.00	1.00	1.05

Source: *Authors' calculations using DEAP2.1 software.*

In summary, we conclude from the above that the 5% improvement in factor productivity is mainly attributed to improved technology, and insurers experienced no improvement in technical efficiency (EFFch) due to the lack of improvement in pure technical efficiency (PTEch) and scale efficiency (SEch) during the period on average.

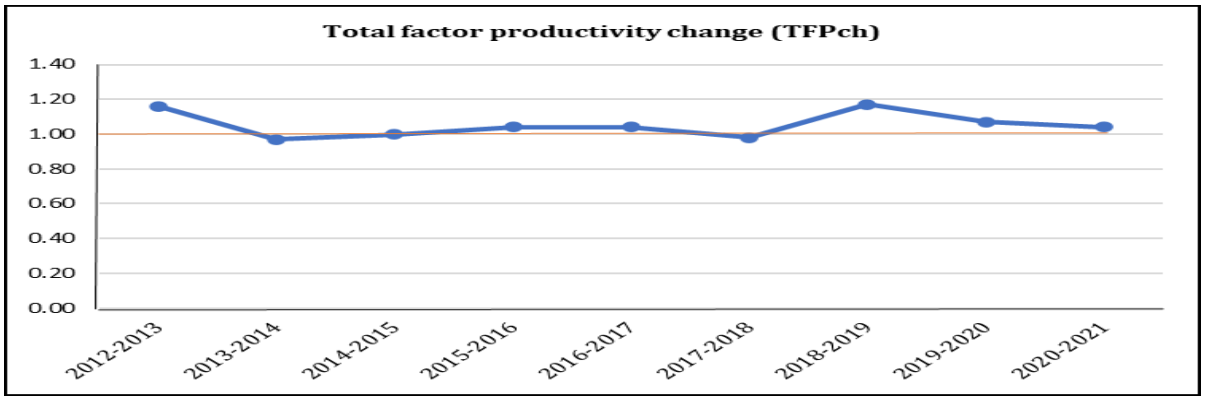

Figure 2: Overall trend of mean TFP for non-life insurers in Egypt during the period (2012-2021)

Analysis of insurer-specific factors that influence total factor productivity

To analyze the insurer-specific factors assumed to explain total factor productivity (TFP) differences. Table 6 presents the descriptive data for the second-stage analysis. The mean increase in the size of insurers' assets is 13.59%. The mean insurer age (Age) of 25.18 denotes the years in operation, while the reinsurance (Rein) value of 46.60 reflects a retention rate of 53.4% for all written business. The claims rate (Risk) of 50.13 shows that the insurer pays out claims amounting to 50.13 percent of its premiums, while the ROE of 22.64 denotes that the

insurer realizes profits averaging 22.64 percent of equity. The market share (M.S.) of 5.34 reflects that the mean insurer's market share constitutes 5.34 percent of total market premiums. The leverage (Lever) of 34.52 indicates that insurers finance their operations with a leverage ratio of 34.52 percent. The return on investment (ROI) of 25.79 reflects an investment ratio of 25.79 percent of the insurer's written premiums.

Table 6: Descriptive statistics for insurer-specific factors (independent variables)

Variables	Size	Age	Rein	Risk	ROE	M.S	Lever	ROI	Dtype
Mean	13.59	25.18	46.60	50.13	22.64	5.34	34.52	25.79	0.29
Std dev.	1.11	19.14	16.37	13.58	10.49	11.31	12.38	14.10	0.46
Min	11.40	4.00	12.20	0.10	-7.00	0.10	14.50	3.71	0.00
Max	17.50	87.00	83.90	79.7	49.20	58.10	78.50	89.90	1.00
Obs.	153	153	153	153	153	153	153	153	153
Correlation matrix									
Size	1.00								
Age	0.714***	1.00							
Rein	-0.021	0.075	1.00						
Risk	0.098	-0.216*	-0.380**	1.00					
ROE	0.117**	-0.123	-0.122	0.144	1.00				
M.S	0.781**	0.754**	-0.094	0.120	-0.111	1.00			
Lever	-0.212*	0.071	0.145	-0.400**	-0.465**	0.025	1.00		
ROI	0.163	0.198***	0.365**	-0.111	0.107**	0.083	-0.001	1.00	
Dtype	-0.183	-0.493**	-0.076	0.291**	0.102	-0.186	-0.206	0.076	1.00

Source: *Authors' calculations using STATA software*; Note: ***, **, and * denote significance at 1, 5 and 10 percent, respectively.

Before estimating the regression models, and to avoid misleading results. We performed a test for correlation coefficients among the independent variables before the regression analysis to assess multicollinearity. according to Kennedy (2008), correlation values do not pose an issue unless they exceed 0.8. The findings shown in Table 6 indicate that multicollinearity in the regression analysis is not an issue. The results are shown in Table 7. They show the relationship between the nine independent variables (insurer-specific factors) and the total factor productivity (TFP) of insurers. We compared the three analyzed models (POLS, FEM, and REM) for total factor productivity (TFP) using the probability F test, the Breusch-Pagan Lagrange (LM) test, and the Hausman test. The analysis indicated that the random effects model (null hypothesis rejected) was the best for the explanation of the differences in TFP.

According to the model test, a random effects (RE) model for the TFPch variable as the dependent variable is obtained in Table 7. The regression equation (equation 6) indicates the influence of the independent variables (insurer-specific factors) on the constant variable, which is 3.3741. When the variables of insurer size, insurer age, reinsurance, claims rate, return on investment, return on equity, leverage, market share, and operating type are constant or zero, the TFPch result will rise by 3.3741 units. The observation results show that the variables of insurer size, insurer age, reinsurance, claims rate, return on investment, return on equity, leverage, market share, and operating type all have an effect of 5.6% on the productivity of both conventional and takaful non-life insurance in Egypt. The R-squared value for these variables is 0.5618. The empirical results show that the regression coefficient of insurer size (size) is -0.0916, which is significant at the 1% level, indicating that it is difficult for large companies to significantly improve their productivity over time due to the bureaucratic process in underwriting and claims as they expand, leading to unproductive expenses. Our findings align with the findings of Cummins and Xie (2016), who found a negative correlation between size and the TFP of property insurers in the United States, and Ming's (2020) research on Malaysian conventional and takaful insurers. However, it differs from the findings of Sukmaningrum et al. (2023), who discovered a positive correlation between size and the productivity of takaful insurers in Indonesia. The TFP

of Egyptian non-life insurers exhibits a negative correlation (-0.0043***) with the insurer's age. The results reflect that older insurers have complex bureaucratic processes and are therefore often unable to use the best available technologies to be productive. This result is consistent with Ming (2020). Our empirical analysis shows that insurer age has a negative impact on TFP and also confirms that Misr, Suez Canal, Allianz, and Egy-Saudi (the oldest insurers in the market) are less productive conventional and takaful insurers during the study period. The TFP of non-life insurers in Egypt positively correlates (0.0009***) with Reinsurance (Rein). The findings reflect that insurers with high reinsurance rates can help improve the TFP of the companies. The findings reveal a negative relationship (-0.0181) between the claims ratio (Risk) and the TFP of Egyptian non-life insurers. This relationship is significant at the 1% level, suggesting that a company's high claims ratio diminishes its total factor productivity, thereby confirming the volatility characteristic of risk occurrence. Therefore, insurers should review their underwriting processes to reduce claims, thereby enhancing their efficiency and productivity. Our findings are consistent with Asghar et al. (2018), while they are inconsistent with Li et al. (2020). The TFP of Egyptian non-life insurers has a negative relationship (-0.0029) with return on equity (ROE), but this relationship is not significant.

Table 7: Regression results for insurer-specific factors influencing TFP of Egyptian conventional and takaful non-life insurers.

	POLS	***FEM***	***REM***
Variables	***TFP***	***TFP***	***TFP***
Insurer size (Size)	-0.0916	-0.2564***	-0.0916***
	(0.0614)	(0.0212)	(0.0139)
Insurer Age (Age)	-0.0043*	0.0136***	-0.0043***
	(0.0037)	(0.0039)	(0.0017)
Reinsurance (Rein)	0.0009	-0.0052***	0.0009***
	(0.0024)	(0.0005)	(0.0002)
Claims rate (Risk)	-0.0181***	-0.0217***	-0.0181***
	(0.0032)	(0.0042)	(0.0032)
Return on equity (ROE)	-0.0029	-0.0011	-0.0029
	(0.0038)	(0.0051)	(0.0038)
Market Share (M.S)	0.0117**	0.0034	0.0117*
	(0.0066)	(0.0152)	(0.0066)
Leverage (Lever)	-0.0055	-0.0089	-0.0055**
	(0.0035)	(0.0072)	(0.0015)
Return on investment (ROI)	0.0043	0.0082**	0.0043
	(0.0027)	(0.0042)	(0.0027)
Operating type (Dtype)	0.1190*	---	0.1190***
	(0.0929)		(0.0287)
Constant	3.3741***	5.6850***	3.3741***
	(0.8588)	(2.1119)	(0.8588)
Obs.	153	153	153
F-statistic	5.63***	4.38***	
Wald chi2(9)			50.71***
R-squared	0.2618	0.4338	0.5618
Adj R-squared	0.2153	0.3981	0.5342
LM-Test			37.50***
Hausman-Test			6.28

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

The TFP of Egyptian non-life insurers has a positive relationship (0.0117) with market share (MS), which is statistically significant at the 10% level. This suggests that insurers with a larger market share can achieve higher productivity by maintaining a relationship with more customers, which can enhance efficiency and productivity, and benefit from cost-sharing and lower costs per unit. Our findings are consistent with Ashraf (2019), but they differ with Zhu (2019) and Li et al.

(2020). We found a statistically significant negative correlation (-0.0055**) between leverage (Lever) and the TFP of Egyptian non-life insurers, which contradicts Jensen and Meckling's (2019) free cash flow hypothesis. This finding shows that leveraging reduces insurers' advantages in debt financing, thereby lowering performance and limiting productivity growth. Our analytical findings align with Eyob (2021), Alhassan and Biekpe (2015), Sukmaningrum et al. (2023), and Ming (2020), but contradict Cummins and Xie (2016), Abbas et al. (2018), and Biener et al. (2016). The findings showed a non-significant positive relationship (0.0043) between the return on investment (ROI) and the total factor productivity of Egyptian non-life insurers.

The regression coefficient for the operation type (Dtype) is 0.1190, which is significant at the 1% level. This means that takaful insurers make a bigger difference than conventional insurers in improving the TFP of Egypt's non-life insurance industry. The Egyptian insurance sector operates under a dual insurance system consisting of conventional and takaful insurance, similar to Pakistan, Malaysia, and Bangladesh. Although takaful insurance is new to the Egyptian market compared to the well-established conventional insurance in the market, in a short time it has become a competitor to conventional insurance, as empirical research has shown that takaful insurers have clear efficiency and productivity advantages compared to conventional insurers. Interestingly, the mean TFP values of takaful insurers were 1.08, surpassing the 1.04 values of conventional insurers. This may be due to the fierce competition within conventional insurers, leading to high non-productive expenses (advertising and distribution costs). On the contrary, takaful insurance operators are steadily launching direct distribution channels and do not charge additional commission fees for takaful products (Mourad, 2018). Furthermore, they possess superior advantages in terms of resources, management, and technology, leading to a higher TFP. This result is consistent with Benyoussef & Hemrit (2019), who found the same level of TFP between conventional and takaful insurers, while it is inconsistent with Kamran et al. (2023) in Pakistan and Ming (2020) and Bao (2018) in Malaysia.

5. Conclusions and Recommendations

This research utilizes panel data from 17 conventional and takaful non-life insurers in Egypt from 2012 to 2021 and employs the two-stage Malmquist productivity index model to compute the TFP of these insurers. It then uses the total factor productivity value (stage 1) as a dependent variable to construct a panel data regression (stage 2), which explores the insurer-specific factors that influence the total factor productivity (TFP) of Egyptian non-life insurers. The empirical analysis indicates that the TFPch trend of both conventional and takaful insurers in Egypt exhibited fluctuations throughout the study's period. However, non-life insurers in Egypt generally cannot operate profitably because the value of TFPch is negative. To be productive, non-life insurers in Egypt can start introducing new ideas and benefit from rapid technological progress. Therefore, we anticipate that companies will enhance their productivity and advancement by fostering innovation in the technology sector. The analysis of the change in technical efficiency (EFFch) reveals a slight increase in the TFP of Egypt's non-life insurance sector, although it remains in an unstable stage. The technological progress change (Tch) plays an important role in improving the average value of the total factor growth rate during the study period, while the impact of the comprehensive change in technical efficiency (EFFch) is not significant. This indicates that Egypt's non-life insurance market is growing in size, yet it still requires improvement at its technical level. There is still significant potential to enhance the TFP of the non-life insurance sector by enhancing the technical level.

The results revealed that the insurer-specific factors influencing the productivity of conventional and takaful non-life insurers in Egypt are insurer size, reinsurance, insurer age, claims rate, market share, operating type, and leverage. Therefore, the management of non-life insurers in Egypt should focus on those factors to improve the company's productivity, as they provide some guidance on important issues. For example, insurers seeking higher levels of productivity can reduce their volume of operations, claims rate, and financial leverage and increase reinsurance

amounts and market share. This research contributes to a large body of empirical and stakeholder literature. For continued competitiveness in Egypt's non-life insurance industry, regulators should establish regulations. Secondly, companies can determine the productivity-enhancing potential of their resources. Third, the research will provide the general public with information for analyzing the productivity and growth of the non-life insurance market, whether conventional or takaful. Furthermore, regulators must consider macroeconomic factors to ensure stability and improve the competitive environment of the non-life insurance sector.

6. Limitations and Future Research Directions

Although this research provides valuable insights into the TFP of both types of insurers and the factors that determine them, it is important to recognize several limitations. First, the research focused on non-life insurers, allowing for further research on life insurers. Second, it focused on insurer-specific factors as determinants of productivity, providing the opportunity to explore or incorporate additional research variables, such as macro- and microeconomic variables, that may impact the TFP of insurers. Finally, further research can examine productivity for comparative purposes using econometric methods for estimating TFP, such as SFA.

References

Abbas, M., Khan, A. Abbas, S. & Mahmood, Z. (2018). Determinants of Cost Efficiency of Takaful and Conventional Insurance Firms of Pakistan. *Review of Economics and Development Studies*, 4 (2), 331-340. Doi: 10.26710/reads. v4i2.418

Abdellatif, M. & Xie, Y. (2024). Efficiency Analysis of Traditional and Takaful Insurance Firms in Egypt: A Two-Stage Efficiency Model, *International Journal of Science and Business*, 41(1), 200-217. https://doi.org/10.58970/IJSB.2473

Abdul Kader, H., Adams, M., Harwick, P., & Kwon, W.J. (2014). Cost efficiency and board composition under different takaful insurance business models. *International Review of Financial Analysis*, 32: 60-70.

Abu Assi, S. (2022). Estimating the capacity, efficiency, and productivity of Syrian private insurance companies. Ph.D. thesis, School of Insurance and Economics, *University of International Business and Economics*, China.

Akhtar, M. H. (2018). Performance analysis of takaful and conventional insurance companies in Saudi Arabia. *Benchmarking: An International Journal*, 25(2), 677–695. https://doi.org/10.1108/BIJ-01-2017-0018

Al Amri, K., Cummins, J.D., & M.A. Weiss. (2021). Economies of scope, organizational form, and insolvency risk: Evidence from the takaful industry. *Journal of International Financial Markets, Institutions and Money*, 70, 101259. https://doi.org/10.1016/j.intfin.2020.101259

Alhassan, A. L., & Biekpe, N. (2015). Efficiency, Productivity and Returns to Scale Economies in the Non-Life Insurance Market in South Africa. *The Geneva Papers on Risk and Insurance Issues and Practice*, 40(3), 493-515.

Ali, C., Houshang, H., & Yavuz, K. (2021). An Efficiency Analysis of Takaful Insurance Industry: A Comparative Study. *Journal of Asian Finance, Economics and Business*, 8(7), 111-120. doi: 10.13106/jafeb.2021.vol8.no7.0111

Altuntas, M., Berry-Stölzle, T.R., & Cummins, J. D. (2021). Enterprise risk management and economies of scale and scope: evidence from the German insurance industry. *Annals of Operations Research*, 299(1): 811-845.

Ashraf, M. S. (2019). Efficiency and productivity in takaful and insurance industries of Pakistan: A comparative analysis. *Ph.D. thesis*, Universiti Utara Malaysia.

Bansal, R., and Singh, D. (2021). Efficiency drivers of insurers in GCC: an analysis incorporating company-specific and external environmental variables. *Cogent Economics and Finance*, 9(1): 1-25. Doi: 10.1080/23322039.2021.1922179

Bao, N. J., Ramlan, R., Mohamad, F., & Yassin, A. M. (2018). Performance of Malaysian insurance companies using data envelopment analysis. *Indonesian Journal of Electrical Engineering and Computer Science*, 11(3), 1147–1151. doi.org/10.11591/ijeecs. v11.i3.

Benyoussef, S., and Hemrit, W. (2019). Measuring the relative efficiency of insurance companies in Saudi Arabia: The case study of takaful vs. cooperative industries. *Cogent Economics & Finance*, 7(1), 1590818. https://doi.org/10.1080/23322039. 2019.1590818

Biener, C., Eling, M., & Wirfs, J. H. (2016). The determinants of efficiency and productivity in the Swiss insurance industry. *European Journal of Operational Research*, 248(2), 703–714. https://doi.org/10.1016/j.ejor.2015.07.055

Christian, B., Martin, E., & Jan, M. (2015). The Determinants of Efficiency and Productivity in the Swiss Insurance Industry. *Working Papers on Risk Management and Insurance* No. 153.

Coelli, T. J., Rao, D. S. P., O'Donnell, C. J., and Battese, G. E. (2005). An introduction to efficiency and productivity analysis (2nd ed.). New York, NY, United States: Springer. *Science & Business Media*. doi.org/10.1007/b136381.

Cummins, J. D., & Weiss, M. (2013). Analyzing Firm Performance in the Insurance Industry Using Frontier Efficiency and Productivity Methods, in Georges Dionne, ed., Handbook of Insurance. New York: Springer (795-861).

Cummins, J. D., & Xie, X. (2008). Mergers and acquisitions in the US property-liability insurance industry: Productivity and efficiency effects. *Journal of Banking & Finance*, 32(1), 30–55. doi:10.1016/j. jbankfin.2007.09.003

Cummins, J. D., & Xie, X. (2013). Efficiency, productivity, and scale economies in the US property-liability insurance industry. *Journal of Productivity Analysis*, 39(2), 141-164.

Cummins, J. D., & Xie, X. (2016). Efficiency and Productivity in the US Property-Liability Insurance Industry: Ownership Structure, Product and Distribution Strategies. doi:10.1007/978-1-4899-7684-0 6, In book: Data Envelopment Analysis (113-163), Springer.

Cummins, J. D., Weiss, M., Xie, X., & Zi, H. (2010). economies of scope in financial services, a DEA efficiency analysis of the US insurance industry. *Journal of Banking & Finance*, 34(7), 1525–1539. https://doi.org/10.1016/j.jbankfin.2010.02.025

Eling, M., & Jia, R. (2019). Efficiency and profitability in the global insurance industry. *Pacific-Basin Finance Journal*, 57. https://doi.org/10.1016/j.pacfin.2019.101190

Eling, M., & Luhnen, M. (2010). Efficiency in the international insurance industry: A cross-country comparison. *Journal of Banking & Finance*, 34(7), 1497–1509. doi: 10.1016/j.jbankfin.2009.08.026

Eyob, N. G. (2021). Cost and Profit Efficiency of Ethiopian Insurance Industry and its Determinants: Application of Stochastic Frontier Analysis. Master's thesis, *College of Business and Economics of Addis Ababa University*.

Färe, R., Grosskopf, S., & Margaritis, D. (1994). Productivity growth, technical progress, and efficiency change in industrialized countries. *American Economic Review*, 84(5), 1040–1044.

Färe, R., Grosskopf, S., & Margaritis, D. (2008). Efficiency and productivity: Malmquist and more, In Fried, H.O., C.A.K. Lovell and S.S. Schmidt (eds.) *The measurement of productivity efficiency and productivity growth*. Oxford University Press, New York.

Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society*. Series A (General), 120(3): 253-290.

Ferro, G., & Leon, S. (2018). A stochastic Frontier analysis of efficiency in Argentina's non-life insurance market. *Geneva Papers on Risk and Insurance-Issues and Practice*, 43(1), 158–174.

Gharaei, A., Karimi, M., & Hoseini Shekarabi, S. A. (2020). Joint economic lot-sizing in multi-product multilevel integrated supply chains: Generalized benders decomposition. *International Journal of Systems Science: Operations & Logistics*, 7(4), 309–325. https://doi.org/10.1080/23302674.2019.1585595.

Hafez, M. (2022). Using the stochastic frontier analysis model to measure cost efficiency in life insurance companies in the Egyptian market. *Journal of Financial and Commercial Studies*, Beni Suef University, 12(2): 512-540.

Hafez, M. M., & Hassan, M. A. (2020). Using the Two-Stage Data Envelopment Analysis Method to Measure the Relative Efficiency of General Insurance Companies in The Egyptian Market. *Alexandria University Journal of Administrative Sciences*, 57 (3): 157-186. doi: 10.21608/ACJ.2020.105242

Huang, W., & Eling, M. (2013). An efficiency comparison of the non-life insurance industry in the BRIC countries. *European Journal of Operational Research*, 226(3), 577–591. https://doi.org/10.1016/j.ejor.2012.11.008

Ilyas, A. M., & Rajasekaran, S. (2019). An empirical investigation of efficiency and productivity in the Indian non-life insurance market. *Benchmarking: An International Journal*, 26(7), 2343–2371. https://doi. org/10.1108/BIJ-01-2019-0039.

Jaloudi, M. (2019). The efficiency of Jordan insurance companies and its determinants using DEA, slacks, and logit models. *Journal of Asian Business and Economic Studies*, 26(1): 153-166. https://doi.org/10.1108/JABES-10-2018-0072

Jensen, M. C., & Meckling, W. H. (2019). Theory of the firm: Managerial behavior, agency costs and ownership structure. In Corporate Governance (77- 132). Gower.

Kamran, M., Ramzan, M., Ullah, B., Hayat, M., & Khalil, J. (2023). Assessing the Efficiency of Takaful and Insurance Companies in Emerging Markets. *Journal of Social Sciences Review*, 3(2): 613-628. https://doi.org/10.54183/jssr.v3i2.292

Kennedy, P. (2008) A Guide to Econometrics, 6th edn. Malden, MA: Blackwell Publishing.

Keong, C. (2015). Measuring the efficiency between conventional general insurance and general takaful in Malaysia. Master thesis, *University Utara Malaysia*.

Lee, H. S., Cheng, F. F., Har, W. M., Md Nassir, A., & Ab Razak, N. H. (2019). Efficiency, firm-specific and corporate governance factors of the Takaful insurance. *International Journal of Islamic and Middle Eastern Finance and Management*, 12(3), 368–387. https:// doi.org/10.1108/IMEFM-06-2018-0187.

Li, Z., Li, Y., & Long, D. (2020). Research on the improvement of technical efficiency of China's property insurance industry: a fuzzy-set qualitative comparative analysis. *International Journal of Emerging Markets*, 16(6): 1077-1104. DOI 10.1108/IJOEM-01-2020-0091.

Lim, Q., Lee, H., & Har, W. (2021). Efficiency, productivity and competitiveness of the Malaysian insurance sector: an analysis of risk-based capital regulation. *Geneva Papers on Risk and Insurance-Issues and Practice*, 46(1), 146–172.

Luhnen, M. (2009). Determinants of efficiency and productivity in German property-liability insurance: Evidence for 1995-2006. *Geneva Papers on Risk and Insurance*, 34(3), 483–505. doi:10.1057/gpp.2009.10

Ming. L. Q. (2020). Efficiency, productivity and competitiveness of the insurance industry in Malaysia. Master's thesis, *University Tunku Abdul Rahman*.

Murad, A. F. (2018). Takaful insurance in the Egyptian market: a future vision. *Journal of Contemporary Commercial Research*, 32 (1): 34-96.

Murad, A. F. (2021). Measuring and estimating the operational efficiency of Egyptian insurance companies using stochastic frontier analysis (SFA). *Journal of Financial and Business Research*, 22 (2): 834-899.

Nourani, M., Kweh, Q. L., Ting, I. W. K., Lu, W-M., & Strutt, A. (2022). Evaluating traditional, dynamic and network business models: an efficiency-based of Chinese insurance companies. *The Geneva Papers 47*: 905-943.

Othman, E. S. (2021). Using Data Envelopment Analysis (DEA) Method for Measuring the Financial Efficiency of Life Insurance Companies in The Egyptian Market. *Journal of Financial and Commercial Studies*, Egypt, 19(3): 305-324.

Rahman, A. (2015). Comparative Study on the Efficiency of Bangladeshi Conventional and Islamic Life Insurance Industry: A Non-Parametric Approach. *Asian Business Review*, 3(4), 80-91. doi:10.18034/abr. v3i4.284

Reyna, A. M., Fuentes, H. J. & Núñez, J. A. (2022). Response of Mexican life and non-life insurers to the low-interest rate environment, *The Geneva Papers* 47: 409-433.

Saeed, A. AL. (2018). A quantitative method for measuring production efficiency in takaful insurance companies. Master's thesis, *Cairo University*, Faculty of Commerce.

Segal, D. A. (2003). Multi-Product Cost Study of the U.S. Life Insurance Industry. *Review of Quantitative Finance and Accounting*, 20:169-186.

Shaddady, A. (2022). Business environment, political risk, governance, Shariah compliance and efficiency in insurance companies in the MENA region. *The Geneva Papers*, 47: 861-904.

Singh, A., & Zahran, Z. (2013). A Comparison of the Efficiency of Islamic and Conventional Insurers. *Towers Watson Technical Paper* No. 2100531.

Sukmaningrum, P., Hendratmi, A., Abdul Shukor, S., Putri, M., & Gusti, R. (2023). Determinants of sharia life insurance productivity in Indonesia. *Heliyon 9*. https://doi.org/10.1016/j.heliyon.2023.e16605

Sun, B., Xia, Y., & Cao, W. (2012). The efficiency evaluation of property insurance companies based on two-stage correlative DEA models. in Proceedings of the Management Science and Engineering (ICMSE) 2012 International Conference on, pp. 699–712, IEEE, Harbin, China, November 2012.

Sun. Z. (2020). Research on the Factors Affecting the Total Factor Productivity of Chinese Life Insurance Companies. *Archives of Business Research*, 8(1): 38-50. doi: 10.14738/abr.81.7426.

Taha, T. A. (2024). Efficiency analysis of insurance companies operating in the Egyptian market using data envelopment analysis. *Scientific Journal of Commerce and Finance*, 44(3), 101-137. https://caf.journals.ekb.eg

Venkateswarlu, R., & Rao, G. (2019). Productivity analysis of Indian non-life insurance firms using Malmquist total factor productivity index, *International Journal of Operations and Quantitative Management*, 25(2), 91–108.

Wanke, P., & Barros, C. (2016). Efficiency drivers in Brazilian insurance: a two-stage DEA meta frontier-data mining approach. *Economic Modelling*, 53(2), 8–22.

Worthington, A., & Hurley, E. (2002). Cost efficiency in Australian general insurers: a non-parametric approach. *British Accounting Review*, 34(2), 89–108.

Yaisawarng, S., Asavadachanukorn, P., & Yaisawarng, S. (2014). Efficiency and productivity in Thai non-life insurance industry. *Journal of Productivity Analysis*, 41(2), 291–306.

Yu, F., Chen, H., Luo, J., & Kuang, H. (2021). Measuring Total Factor Productivity of China Provincial Non-Life Insurance Market: A DEA-Malmquist Index Method. *Hindawi Scientific Programming*, Volume 2021, 3022658, 10 pages. https://doi.org/10.1155/2021/3022658

Zhu, J. (2019). China's Insurance Companies' Efficiency: An Empirical Study. Ph.D. thesis, *ISCTE University Institute of Lisbon*.

Published by

IJSAB International